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VOL. LI., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

SOME SCIENTIFIC INVESTIGATIONS AFFECTING QUEENSLAND.

BY PROFESSOR H. C. RICHARDS, D.SC.

Geology Department, University of Queensland.

[Delivered before the Royal Society of Queensland, 27th March, 1939.]

Three years ago, on my return from over a year abroad, during which time many research institutions were visited and many scientific investigators were met, I addressed this Society on the part it had played and should continue to play in matters pertaining to research.

Some of you will remember my reminding you that when this Royal Society was founded—over fifty years ago—those responsible decided very wisely that the objects should be:—

> "The leading objects for which this Society is established are the encouragement of scientific research and the study of new applications and laws."

Since that reminder to you I have thought much about the matter, as it has been my good fortune to be associated very closely with many research activities, both within the State and beyond it.

Events of world-wide importance move rapidly these days, and the necessity for this Society to do what it can in furtherance of its "leading objectives" was never more urgent than now.

You do not need to be told of the changes which have come over the world's methods of trading, and you are all well-informed as to the influence of these as far as the Empire is concerned, and Australia in particular. Things have changed very decidedly, and we need to use to the very best advantage all our resources—material, research, and human.

The time has not long passed when those who knew the value—economic and otherwise—of research had to implore those whom it would most benefit as to the wisdom of supporting research investigation both financially and in kind.

It is one of the most hopeful features of our outlook to-day that there is an ever-widening appreciation of the value of these research inquiries.

When times are bad—as they were in Australia in 1929 onwards—everybody turns to the economist and to the research scientist, but there is still a very human tendency to forget about the scientist when times of prosperity return, and then in times of adversity to cast the blame on him for not doing something to prevent these unfortunate circumstances.

Perhaps the best, but also the most unfair, tribute paid to the scientist is the blame cast upon him for the development to-day of

tremendous methods of destruction of structures and of mankind. Presumably there are those who think that the progress of science may be halted. It cannot be halted, nor should it be. Man himself should develop, and in his own way keep pace with this development. This matter is an extremely serious one, but, I fear, a fruitless one for me to pursue this evening. May I, however, take up with you the question of aiding and abetting the conduct of pure research investigations?

The Commonwealth Government is an enlightened one as far as research investigations are concerned, especially those relating to the application of science to industry. Through the Council for Scientific and Industrial Research, we now spend about a quarter of a million pounds yearly on research investigations. These are nearly all affecting the primary industries, and as time goes on, with our mandate to engage in the research investigations relating to secondary industries, this figure must, of course, increase. The State Governments—especially that of Queensland—also are very enlightened in this respect, and they are working in the closest co-operation with the Commonwealth.

What this Society, along with its sisters and universities, needs to do is to safeguard the position of pure research, because applied research of an economic and industrial nature can yield only results in accordance with the development of pure research.

"Research for its own sake" is a slogan that every one of us should paste in his hat. Governments now have learned the wisdom of finding money for the applied researches; while years ago they may have prospered without organised industrial research, to-day they know they will fail without it. But they seldom realise how fundamental to these applied researches is the encouragement and development of pure research investigations. On Royal Societies and universities there are very heavy responsibilities in this matter. It is well to remember that the teachers of advanced science must engage actively in research investigations if they hope to inspire their students. They must attempt to advance the frontiers of knowledge, or the frontiers will leave them rapidly behind.*

Mention should be made of the important scientific investigations mainly in the nature of pure research which have been going on in regard to the Great Barrier Reef over a period of sixteen years. This work was initiated within Queensland, and is not only administered from here but has also been carried out mainly by Queensland investigators, with the exception of the work of an expedition of British Scientists in 1928-29, which was organised by the Great Barrier Reef Committee.

The results of these investigations, both by the members of the expedition and by the local workers, are published from time to time and are known to those scientists throughout the world who are concerned in coral reef investigations. This work is continuing year in and year out, and is a good illustration of solid, quiet, pure research along a programme carefully worked out and pursued in an unostentatious fashion.

Associated with the pure researches are certain applied researches of industrial importance, but it may be said definitely that the value of these latter investigations is based completely upon the pure research. The use in the cement making industry to-day in Brisbane of the coralline deposit at Mud Island in Moreton Bay instead of the limestone material

* Soviet Science, J. G. Crowther, page 20.

from Gore is an excellent illustration of the economic results, often of great importance, which follow upon pure research entered upon simply in the spirit of "research for its own sake."

May I appeal to every member of this Society to help in the encouragement of pure research, and, as a reminder of its absolute necessity in the proper development of our country, may I furnish a few instances which, if necessary, you can use when you are "passing on the torch"?

As pointed out by Sir Frank E. Smith,* it was Roger Bacon who first urged the experimental method in gaining knowledge, and 300 years later Gilbert became famous for his experimental work, especially that on magnetism. Galileo, a contemporary of Gilbert, also, as you know, favoured, in spite of tremendous opposition, the experimental method. The first great revolution in industry which resulted from the work of Black, James Watts, and others on the nature of steam followed upon the results of experiments.

Who would have thought that the experimental work of twenty-five years ago which resulted in the then laboratory toy we now know as the *photo-electric cell* was producing something that to-day is a vital link in the "talkies," is used as a burglar alarm, operates in large stores to switch lights on or off, with variation in daylight illumination, groups electric lamps according to their candle-power, arranges cigarettes in rows with the imprinted name uppermost, selects cigars by the colour of the outside leaf, controls the magnitude of electric currents, is used in television, and furnishes a completely unbiassed decision as to the order in which racehorses finish?

Unquestionably, in the past there has been a considerable amount of capital (pure research discoveries) accumulated, and we have been living on that capital. It must be supplemented, however, and the need for constant replenishment must be appreciated far more widely than is the case to-day, and especially by Governments. One may say that nearly every fundamental discovery has originated in the laboratory devoted to pure science when no regard was being paid to its possible practical application.

Faraday's discoveries, in which lay the germ of all our dynamos and electrical power units, were believed originally to be of no practical importance. Pasteur's researches, which led him to study fermentation problems and, later on, the control of disease, were originally conducted as pure scientific investigations. It took over twenty years from the time that Clerk Maxwell mathematically proved the existence of electromagnetic waves for them to be actually produced and recognised, and on this we have based to-day the great system of wireless and radio as we know it. Mendel's discoveries in heredity and cross-breeding, which have meant millions and millions of pounds to us in Australia in connection with the development of our modern varieties of wheat, originally had no industrial application.

In spite of the above, one of the main difficulties to be overcome in Australia is the recognition of the importance of scientific research and the creation of an atmosphere which will encourage research in all departments of knowledge.

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* Norman Lockyer's Lecture, 1932, page 6.

Were it not for the capacity to float off separately the lead sulphide and the zinc sulphide from the Mount Isa ore, we should not have had the big industrial development at Mount Isa which has already seen the expenditure of so many millions of money.

There has been a tremendous change during the last few years, and many who viewed the scientist with suspicion, and certainly would have none of him about their precincts, now come almost cap in hand to invoke his aid, and, as I could indicate to you from C.S.I.R. experience, they come now with hands full of money begging us to do the scientific work which they now realise is of such fundamental importance.

Referring to the co-ordinated research efforts so often talked of, the following remarks by Dr. F. P. Keppel, the President of the Carnegie Corporation of New York, are interesting*:—

"There are fashions in research, just as there are fashions in hats and gowns. To-day we have the endocrines, the cosmic rays, heavy hydrogen, the outer galaxies, pioneer belts. There are fashionable techniques—the bombardment of the atom, the partial correlation, the private life of the long-suffering banana fly, the photo-electric eye, linguistic atlases. For a while we are all excited about the possibility of deliberately planned co-operative research.

"We are not so sure to-day.

"It was, by the way, the degree of foundation support going to enterprises of this kind a few years ago which evoked the cry from my predecessor on this platform, Professor Zinsser, of Harvard:—

> " 'Research Councils and foundations organise co-operative researches, thinking that the shy truth can be snared by the noisy advance of a well-drilled company of technicians, forgetting that discovery was ever a solitary task, in which co-operation must be spontaneous, asked as the need arises by one lonely seeker from another.' "

In support of the view that it is absolutely essential to have pure research fostered and encouraged, let us see what our very practical friends in U.S.A. think about it.

Dr. Keppel estimated that in 1927 some £43,000,000 was spent in U.S.A. and about 90 per cent. of the funds came from industrial and commercial bodies. Much of it was necessarily routine and utilitarian research or investigation, but there are many shining examples to the contrary—e.g., Langmuir's work in the realm of pure physics is known the world over—he is on the pay-sheet of the General Electric Company. Other instances are contributions by scientists on the staff of the American Telephone and Telegraph Co.—one on endocrinology, another on the physics of light and the chemistry of pigments, and another on personal analysis. None of these has anything much to do with telephones or telegraphs.

Of course, we need scientific workers of the very best calibre, and, speaking generally, the best men for these research posts are our own trained graduates who are "topped off," if necessary, by carrying out post-graduate or research activities in carefully selected institutions abroad—in those places where they may receive the best inspirations and

* F. P. Keppel: Philanthropy and Learning, page 15.

where they may become acquainted with the right technique. Naturally, we will be well-advised to recruit to a limited extent our research services from time to time by carefully selected people from abroad, but we will find it increasingly harder to induce the old country to send us good men—it wants them all herself—but, fortunately, the local product, adequately trained and experienced, has already demonstrated a fitness to undertake the tasks the country asks of it.

The provision recently by the Commonwealth Government of £30,000 per annum to be used through C.S.I.R. in conjunction with the several universities in Australia in the stimulation of research and in the training of young graduates as research investigators was most wise. It has provided facilities which were sadly needed—in our own University especially—and now the way is clear for anyone who has a "flair" for research investigation to engage in such an activity. The provision of these facilities should be known as widely as possible, and the Commonwealth Government and the University would welcome into this scheme those qualified and competent to serve their country in this all-important matter of research.

While more details will be given of applied researches than of pure researches, it is hoped that the impression will not be left that pure researches, as such, have no sound establishment in Queensland and in Australia, for quite definitely they have.

Applied researches have prominence in this address because most of those who read it will be more concerned in that direction, and the necessity of applying the results of scientifically conducted experiments to our industrial activity is of such paramount importance.

As already indicated, applied researches can progress only on a sound basis of pure research. A long list of scientific research into physical, chemical, engineering, zoological, botanical, geological, and palæontological matters could be drawn up, but anyone especially interested is advised to consult the proceedings of the various State Royal Societies and of the Australian Institution of Engineers, also the Memoirs of the various State museums.

Let us now consider some of the research investigations which have taken place in the past, which are going on at the present day, and which will need to take place in the future. A purely cursory examination indicates that to-day a vast amount of research is taking place within Australia, and in Queensland, in particular, a very wide field indeed is being covered. This field has, generally speaking, been in the realm of primary industry, but we are on the eve of an enormous development on the secondary industrial side which will necessitate the application of a considerable amount of energy, time, and money.

With confidence one may review the past record of achievement and think particularly of the spectacular success which attended the subjugation of the prickly-pear problem by biological control. Let us realise that going on at the present time is this extremely interesting work on chilled beef which brings in its train the necessity for research investigations into the fattening of cattle on improved pastures in our coastal regions. The realisation that the base-metal mining and milling industry at Mount Isa was determined by the capacity to apply selective flotation methods to the various sulphides in turn brings home to one the part which such investigations play in the building-up of a country by the provision of raw materials for industrial activity.

It has been borne in upon us in a rather brutal manner these last few years that we must learn to stand upon our own legs and that competition in the world's markets to-day, as far as our primary products are concerned, is very keen indeed. Not only must we learn to produce the goods, but we have to transport them and market them, often under grave disadvantages as far as distance and time are concerned. In Great Britain a certain measure of preference to Empire-produced goods exists, but we have keen competition from our sister Dominions, especially Canada, South Africa, and New Zealand. While New Zealand and Australia together face the almost equal and great handicap of distance, South Africa, like the Argentine, our great competitor for so many products, has advantages over us.

In matters relating to foodstuffs, these disadvantages hit us rather severely, but, as a result of long, patient, and careful research investigations, the disabilities are becoming lessened day by day, but possibly will never be overcome completely in all circumstances. It is only by research investigations, however, that these disabilities can be reduced to what may be spoken of as a reasonable vanishing point.

The experiment made at the Low Temperature Research Station in the University of Cambridge some years ago as to length of time a piece of beef could be kept without decomposition was the basis on which our chilled beef export trade is built. It was found that by chilling and providing an atmosphere containing a certain percentage of carbon dioxide the sound life of beef could be much extended.

It is a far cry from that original experiment to the existing position, and it is pleasing to note that in Brisbane so much of the research on chilled beef has been done by C.S.I.R. officers provided with facilities by the Queensland Meat Board.

In Queensland we do well to remember that at present our primary products are of chief importance, and it is useful to recollect that about 80 per cent. of the value of what we send away is produced directly and indirectly from the land.

In connection with these primary products, we have some five considerations to bear in mind:—

(1) The preparation for the crop, whatever it may be;

(2) The production of the crop;

(3) The harvesting;

(4) Preparation for marketing;

(5) Transport to markets.

Speaking generally, our record is satisfactory in the first three.

Unseasonable factors over which at present we have no control at times have to be met, but we can take a fair degree of satisfaction in the knowledge that, relatively to other countries, we hold our own in these matters. Regarding (4)—the preparation for marketing—we cannot deny, avoid it as we would wish, that we are very remiss in many directions, and in respect to (5)—transport to markets—we have very grave disabilities to overcome, mainly owing to distance and time.

Research investigations are more applicable and fruitful of results in the matters relating to the preparation and the production of the crops than in the others, but transport difficulties are grave.

All the beneficial results from these research investigations will, however, be much depreciated if the preparation for marketing is not carried out properly, and I am afraid that we in Australia are very neglectful in this matter. People here refuse to believe this, I know, but the agents in Covent Garden markets have told me, and will tell you also; moreover, they will show you the evidence, which cannot be denied —seeing is believing!

In many cases the results of research in other countries may be lifted readily and applied out here with beneficial results. Unfortunately, this cannot always be done, and in this respect, perhaps, Queensland is at a greater disadvantage than some of her sister States, because the country is either sub-tropical or tropical, and because of the White Australia policy.

We can take much quiet satisfaction in the developments which have taken place, but we must accept the challenge in regard to the difficulties, and also appreciate the fact that these difficulties can be met in one way only, and that is by the application of the results of research investigations carried on relentlessly year in and year out.

Now let us turn to the dairying industry. In Queensland there has been a perfectly wonderful expansion, and to-day, under normal seasonal conditions, we produce something like five times as much butter and cheese as we did twenty years ago.

The industry is conducted right from the southern border of the State up to the Mossman area, about 1,000 miles further north (a range of latitude of some 12 degrees), and for some 400-500 miles within the tropics. This performance is unparalleled elsewhere, but it brings with it certain definite problems.

The results of all the research on butter and cheese cultures, on improved pastures, &c., in Denmark may be lifted, holus-bolus as it were, and be applied with great success in New Zealand, or, say, Victoria, because of similar climatic conditions. But you cannot do it for this State because of the different climatic and pasture conditions. We have to tackle our own problems and work them out ourselves if we are going to continue the success which has already attended this wonderfully expanding industry. Such things as the proper selection of cows, the use of good bulls, the need for milk-testing, and the necessity of proper hygienic conditions, of course, when more extensively and better applied, will do much, but the climatic conditions of the industry here and the peculiarity of our pastures have to be carefully studied, evaluated, and the results applied.

While one speaks eulogistically of this very great extension of an industry, one often wonders whether in the past the exploitation of certain resources, especially of the non-recurring mineral type, has been of as much benefit to the State as it might have been. The question of whether the State should allow non-recurring resources to be exploited until the fullest investigation as to their amount, quality, and character has been made is a very important one. While not bewailing the mining in the past of very important auriferous deposits in Charters Towers, Gympie, Croydon, and elsewhere, the fruits of which both directly and indirectly did so much to bring about the development of Queensland, I would like to draw your attention to the exploitation of the coal resources of the Ipswich area. Here we have closely adjacent to a big

city which in the future will be very much more important as a manufacturing centre than it is to-day material which, as marketed at present, must be rated as a relatively inferior coal product, especially for steam-producing purposes. The development of this field by a large number of small collieries has not lent itself suitably to the introduction of modern coal-washing plants, and so we find there is placed upon the market, at a relatively high cost, a dirty product with a high ash content not very acceptable to many who must use it.

This same coal has many virtues as a source of by-products important in industry, and perhaps in the not-too-distant future will have a value as a raw material for conversion into oil infinitely above its present steam-raising value.

Please don't misunderstand me. I don't suggest we should hold up the development of a country, or that we should advocate the non-use of this coal; but it may well be that it would have been a far better thing for Queensland over a long term of years if there had been a less active operation upon the relatively limited coal resources of this field. The application of research investigations to such material is of far-reaching importance in answering such questions as I have raised.

At Broken Hill many years ago there were evolved for the first time anywhere wet methods of concentrating the lead-sulphide content of unaltered ore-bodies. In the evolution of mechanical devices for harvesting crops and in the discovery of dry-farming methods long before they were termed such in America—Australia has shown her inventiveness through her research investigations. The production of rice in the Leeton irrigation area of the Riverina by the application of wholesale methods of cultivation and harvesting, such as are used in wheat-farming, has been attended with great success, especially in regard to the cost of production.

In the past there has been evolved that wonderful Australian animal which we call the Australian Merino sheep. We cannot retrace the steps of its evolution to see exactly how this wonderful end-point as far as a wool-producer has been achieved, but of the results there is no doubt, as the whole world acclaims.

All of these achievements show the capacity of the people in this country to face up to their own problems and to apply research investigations with beneficial results.

With pride, Queensland may talk of the triumphal march of progress which has attended not only the production of sugar-cane tonnage per acre, but also the efficiency of the milling of that material by white men within the tropics.

Some ten years ago three University science graduates were sent abroad for a protracted period to study various aspects of sugar production. Subsequently they were placed in executive positions. The Bureau of Sugar Experiment Stations, as a result, has a strong and sound scientific leavening, and developments of great importance to the industry have taken place in both field and mill.

The following table and subsequent observations which have been furnished by the Director of the Bureau illustrate this clearly:—

	Average for Queensland— 1918-1927	1928-1937.
Tons cane per acre	16·51	18·53
Tons sugar per acre	2·17	2·66
Tons cane per ton sugar	7·62	6·97

The increased sugar yields per acre reflect both better farm work and improved milling performance. The yield figures for 1936 and 1937 are even more striking, as they show 21·1 and 20·6 tons of cane and 3·04 and 3·06 tons of sugar per acre, respectively, while the tons of cane required to make 1 ton of sugar were 6·94 and 6·73. The cane and sugar yields for 1938 are estimated to approximate closely to these values also.

Costs of sugar manufacture have been substantially reduced by milling research work; they are reflected in both accelerated crushing rates and improved sugar recoveries. Records for the past ten years only are available, but a comparison of the 1928 with the 1937 data show:—

	1928	1937
Average crushing rate, tons cane per hour ..	47 (1932)	59
Sugar extraction, per cent.	94·2	95·2
Boiling-house efficiency..	95·7	96·7
Tons of added fuel, B.Th.U.'s (millions) per ton cane	2·8	2·4

As far as forests products are concerned, we find in Queensland especially a very active programme of research in the extension into the field of the results of scientific investigations. Seasoning, utilisation, chemistry, wood structure, timber physics, mechanical properties, preservation, plywood veneers and glueing, and the many uses of such products as gums, essential oils, tan barks, plastics, artificial silk, &c., are all subjects of keen investigation, and, speaking generally, the fundamental research in these matters is done primarily in the Forests Products Laboratory of C.S.I.R., while a certain amount is done also in University laboratories.

Silvicultural research in Queensland to-day is most vigorous and is certain to yield results of great practical importance. It is essential that we know the best means of perpetuating our forests, and, especially, how to do that while at the same time obtaining the maximum production of marketable timber.

In this State the work has been concentrated on those forest types which produce the bulk of the State's timber requirements.

In the making of roads which will last and render the service required, the old order has changed. To-day much testing of soils for stability under varying conditions, of gravels for soundness and binding properties, must be done. In this way only is it possible to build from the bed upwards a stable road, and the application of such research work is now made in most of the States, and it is pleasing to note that it is being done on really sound lines in Queensland.

Later on in this address the question of what dividends are paid by the capital invested in research investigations is considered on a broad basis, but at this stage let us consider whether or not wheat

research in Queensland has paid. I am indebted to the Under Secretary of Agriculture and Stock for the following:—

"In Queensland, prior to the year 1910, the area of wheat harvested did not exceed 100,000 acres, the average yield per acre received being comparatively low, owing to the lack of suitably prolific varieties capable of resisting rust, maturing sufficiently early, and withstanding the effect of moderate storm rains.

"The position is now entirely altered, as a steady expansion has taken place during the last twenty years, culminating in the recent record harvest, estimated to exceed 7,000,000 bushels from an area of over 400,000 acres.

"The wheat-improvement activities of the Department of Agriculture and Stock can claim responsibility for a large share of the expansion noted, especially in regard to average yields per acre, as over half the wheat acreage now consists of varieties evolved at the former Roma Experiment Farm under the direction of Mr. R. E. Soutter, wheat-breeder, and introduced into general cultivation through the medium of trial plots on the Darling Downs.

"Pioneering work was commenced at the Roma farm in the year 1906, with a view to the expansion of agriculture in the Maranoa.

"For the ten-year period 1916-1925, the average yield per acre in Queensland was 11·38 bushels—an average which advanced to 14·92 bushels per acre for the following decade (1926-35), being an increase of over 3 bushels per acre.

"With an acreage of 400,000, and regarding wheat as selling at 3s. 6d. per bushel, the increase represents a gain of £210,000 per annum to the State—a sum which more than compensates for the moderate outlay for wheat research during recent years.

"Naturally, due credit must be given to improved cultural methods, coupled with the introduction of tractors and improved farm machinery, particularly the combine-drill and header-harvester, but in this sphere the Department has also been assiduous in advocating early summer fallowing and the correct use of available machinery.

"At the former Roma Experiment Farm the average yield per acre in both field and experimental blocks considerably exceeded the low average yield for the Maranoa district, thereby demonstrating the value of timely and thorough cultural operations."

Perhaps the most spectacular success of all our great scientific research investigations has been in the biological control of prickly-pear. This, plus (and a very important plus) the administration provided by the State Prickly-pear Land Commission, brought out the wonderful results which are now so well known and which are so justifiably acclaimed.

Australia has during its 150 years of settlement exhibited a capacity to face up to and to solve most of the difficulties which it has met. The protective policy of the country, especially since Federation, no doubt has helped much, particularly in secondary industries and in the sugar-cane growing and milling industry. It is interesting, however, to compare the efficiency of industries such as the steel-manufacturing and sugar-cane growing and manufacturing industries, which have had such

solid protection, with corresponding ones in other parts of the world. If you make this comparison, you will be pleased to find the result is not by any means to the disadvantage of Australia—it is decidedly the other way.

Problems relating to the production of our animal products are very great and are due, like most of our troubles, to the introduction, accidental or otherwise, of organisms not indigenous to this country. The introduction of animals and plants from elsewhere, with the disturbance of the balance arrived at by nature over a long period of time, brings in its train a long list of problems which exercise to the full the energies and ingenuity of our scientists.

I have not the time to deal with the effect of cattle tick infestation, of buffalo fly attack, or of soil deficiencies as far as cattle are concerned, or of the troubles the sheepmen have in Western Queensland in keeping up their flocks by natural increase alone, or of the extremely serious results of the blowfly attack, &c. These matters, together with all the pest problems associated with the growth of crops such as tobacco, cotton, &c., are the subject of much experiment and research by Commonwealth and State.

Brilliant success has attended some of the investigations, such as overcoming prickly-pear and blue mould in tobacco, or in connection with pleuro-pneumonia in cattle; but the challenge offered by the tick, worm nodules, the blowfly, nut grass, and noogoora burr—just to name a very few—demands the best brains provided with all the facilities of training which modern civilisation can provide.

The dividends to be won by the investment of money in researches of this type are great, but there must not be too much impatience exhibited by the investor. The money put out must be regarded as "patient" money which sooner or later is likely to yield enormous dividends.

While most of the researches indicated in this address have been related to either the primary or secondary industries, we must not overlook those on diseases affecting man. The great work in Queensland by a past-president of this Society on filaria made him known throughout the world. I speak of the late Joseph Bancroft.* Several other medical members of this Society have carried out researches of far-reaching importance upon problems which affect man and his environment within this State.

Within the State Department of Health and Home Affairs work on Weil's disease and certain fevers is especially worthy of note.

Medical research of a scientific character will, no doubt, be carried out in Queensland in the future on more extensive lines than in the past now that we have a medical school within the University.

While one may take confidence out of our past performances, it is perfectly clear that our future existence and expansion are based more and more on the application of the results of scientific investigations. In the past we have shown we can produce the men. We certainly have the problems which are to be solved.

Enough has been said to indicate the worthwhileness of research and the necessity for its continuance in this country, but there are those

* Proc. Roy. Soc. Qld., Vol. 11, pages 73-76.

so-called hard-headed business people who ask for figures in support of the paying character of research. One hopes that already in a general way justification for this has been made, but if one must have figures, then let us see what has been the experience in the mother country of recent years.

Amounts spent on research and the results.

J. D. Bernal,* in a recent article on "A Policy for Scientific Research for Britain," discusses the question of what is the scale of benefits which science is capable of giving to industry, agriculture, and health, and he considers that they are not at all realised. He says that, compared with any other form of expenditure, science is capable of yielding a return incomparably greater.

There is, of course, difficulty in getting precise figures on matters of this kind, but figures have been provided by the Department of Scientific and Industrial Research of Great Britain, and they show that research conducted by the Department at a cost of a few thousand pounds "has in many cases saved the industries concerned hundreds of thousands of pounds per annum."

Some economies effected as a result of the researches carried out by D.S.I.R. in connection with six research associations—namely, Iron and Steel, Non-ferrous Metals, Electrical Industries, Refractories, Food Investigations Board, and Cotton—show that on an expenditure of not more than £400,000 economies have been yielded of not less than £3,200,000 per annum. That is to say, a return on the money invested in research has returned a dividend to the industries concerned of 800 per cent. per annum. That is the kind of thing that appeals to your business man!

One is prompted to inquire what amounts are spent on scientific research in different countries. Bernal has calculated that in Great Britain about £4,500,000 is found altogether by the Government, by universities, and by industry.

This sum represents about one-tenth of 1 per cent. of the national income. If this amount be compared with what is spent on advertising, it is not very large, and is even grotesquely small.

Great as this £4,500,000 spent in Great Britain seems to us, it does not show up too well in comparison with that found in some other countries. Bernal estimates that U.S.A. spends £40,000,000 per annum; that is three-tenths of 1 per cent. of the national income, and relatively is three times as much as Great Britain finds.

The Soviet Union, however, is the great spender in this respect, and it has been estimated to be just under 1 per cent. of its national income, while in Germany and Japan, Bernal considers "it probable that the proportional sum spent is between three and five times that of Great Britain."

There is every reason for believing that these estimates are soundly based, and, as far as U.S.A. is concerned, a relatively recent estimate by Dr. F. P. Keppel of the money spent indicated about £45,000,000 per annum, which is rather greater than Bernal's figures.

* Nineteenth Century and After, Jan., 1938, page 99 *et seq.*

Regarding the Soviet Union, Major-General A. G. L. McNaughton* indicates that there are 840 institutes engaged in research, and in 1934 there were 47,900 persons engaged in research work. Their annual expenditure now exceeds £100,000,000 sterling for a population of 186,000,000 people. General McNaughton indicates that the figures continue to increase just as fast as they produce trained workers. As this Canadian authority puts it, consideration should be given to the "cost of not doing it" by other countries.

Now, what of Australia? Here we have a population of less than 7,000,000 and a national income to-day of round about £800,000,000. We have funds for research coming from the Commonwealth and State Governments directly to Government departments and institutes, also indirectly to research organisations financed partly by endowments. Universities contribute materially in this matter; also there has been a marked increase of late from industry itself.

As a result of calculations made by the Information Bureau of C.S.I.R., it would appear that the estimated amount spent in 1938 in Australia from all sources on research investigations was about £1,025,000, or approximately 0·128 per cent. of the national income of £800,000,000. The comparison with that of Great Britain is really very favourable. The sum of something over £1,000,000 is estimated as follows:—

Organisation.	Estimated Sum for 1938. £
Commonwealth—	
C.S.I.R.	272,500
Miscellaneous	112,500
Waite Institute	35,700
Medical Institute	25,600
Universities	82,500
State Agriculture Departments	326,900
Other State Departments	42,500
Industries	128,000
	£1,026,000

= 0·128 per cent. of the national income of £800,000,000.

We have to ask ourselves: Is that enough? It is about all we can spend with our present available trained workers, but I have no doubt about the wisdom of the amount being increased as and when the trained workers become available.

Conclusion.

The purpose of this address has been to place before you the strong claim which the support of research—more particularly of pure research—has upon those of you who really wish to see our country progress.

It has not been my purpose to make the list of researches at all complete, because there is no necessity to do so.

* Address to Canadian Society of Cost Accountants and Industrial Engineers, Montreal, 29th September, 1937.

An endeavour has been made to see what is the business aspect of research, and one hopes that even the hardest-headed critic on that score has been satisfied.

Those who decided over fifty years ago what the objects of this Society should be were wise men, and I feel that to them we must pay a warm tribute.

Let us see that the Royal Society of Queensland in the future continues to live up to the objects for which it was founded!

THE ABSORPTION OF ACIDS BY WOOL.

By L. S. BAGSTER, D.Sc., and MADOLINE V. CONNAH, M.Sc.

(*Read before the Royal Society of Queensland, 29th May, 1939.*)

The absorption of acids by wool has been studied by a number of workers—*e.g.*, Speakman *et al.* (1933). Such work has been chiefly concerned with single acids, and, apart from early experiments of Mills and Takamine (1883), little attention has been given to the behaviour of mixed acids. The present work was undertaken to study the absorption from solution of pairs of mixed acids. The acids employed were hydrochloric, sulphuric, acetic, and monochloracetic.

The wool used was merino from several fleeces of uniform grade from the Roma district. The sample contained body wool of wethers with no belly or skirting. It had a spinning count of 64 to 66 and yield condition about 58 per cent. scoured wool. It was rendered as uniform as possible by spreading and mixing several times before cleaning. During cleaning and sampling further spreading and mixing occurred. The raw wool was washed five times with solvent petrol, air-dried, and then washed with changes of rain water until free from dust. Between washings the material was drained in a centrifuge. It was finally sun-dried. The samples used in experiments were hand-picked to remove foreign matter. The cleaned stock wool was kept in a jar with an atmosphere of 50 per cent. relative humidity attained by placing in the vessel a container with an appropriate sulphuric acid solution. Sufficient material was taken for each experiment to contain 20 grams of dry wool. (The moisture content determined at 100°C. was very close to 12 per cent.)

The work was carried out with room temperatures of 20° to 25°C.

The samples of wool were soaked in the various combinations of acids contained in stoppered bottles, and allowed to stand for five days, by which time tests had shown that all the acid which could be absorbed had been taken up by the wool. The fact that no further acid was removed from solution after five days showed that no appreciable reaction took place between the acids and the containing vessels after preliminary treatment. The wool was stirred occasionally during the five days' soaking. Two hundred c.c.—the quantity of solution used in the majority of the experiments—was absorbed by the wool to a loose sponge, thus giving thorough contact. Samples were withdrawn from the main body of the liquid by means of a pipette and residual acidity determined by titration against carbonate-free alkali in a quarter of the total volume of liquid, using phenol phthalein indicator. The hydrochloric acid content for mixed acids was determined by titration against silver chloride, while the sulphuric acid content was estimated gravimetrically as barium sulphate. The acetic and monochloracetic acids were determined by difference.

The results are shown in Tables I. and II.

The stock acid solutions were all very close to normal. The quantities of stock acid used in the various experiments are shown in the tables in column 1. Table I. gives the absorption of individual acids at different concentrations, the amount of acid being expressed in equivalents per 20 grams of wool, while the results for mixed acids are shown in Table II., where each pair of acids is represented in a double column. A and B in each column give the equivalents of individual acids absorbed.

TABLE I.

Acid (c.c.).	Water (c.c.).	Hydrochloric.	Sulphuric.	Acetic.	Monochlor-acetic.
400	1,000	·0139	·0184	·0070	·0236
		·0132	·0184	·0070	·0234
200	1,000	·015	·019	·0057	·017
		·016	·019	·0057	·018
100	1,100	·0157	·0146	·0029	·026
		·0156	·0146	·0036	·026
400	0	·022	·028	·015	·040
		·022	·028	·016	·039
200	200	·017	·023	·010	·032
		·017	·023	·010	·032
200	0	·019	·026	·015	·037
		·020	·026	·014	·037
		·018	·022	·015	·036
		·018	·025	·015	·036
		..	·025	..	..
150	50	·014	·021	·011	·031
		·015	·021	·011	·030
		·015	·024	·011	·021
		·016	·023	·012	·031
		·016	..	..	..
100	100	·016	·022	·0092	·025
		·016	·022	·0088	·025
		·016	·022	·0094	·025
		·016	·022	·0092	·025
50	150	·016	·017	·0060	·017
		·016	·016	·0057	·018
		..	·019	·0060	·018
		..	·019	·0061	·018
20	180	·012	·015	·0034	·012
		·012	·015	·0034	·012
		·012	..	·0034	·011
		·012	..	·0034	·011
10	190	·0079	·0088	·0021	·0076
		·0079	·0086	·0023	·0076
		·0080	·0084	·0025	·0071
		·0080	·0084	·0021	·0071

TABLE II.

Total Acid c.c.	Proportion.	A HCl.	B Acetic.	A HCl.	B H_2SO_4.	A H_2SO_4.	B Acetic.	A HCl.	B Mono.	A H_2SO_4.	B Mono.*
200 + 1,000 water ..	100 A 100 B	·015 ·014	·0009 ·0013	·0052 ·0052	·012 ·012	·018 ·018	·0004 ·0005	·013 ·014 ·014 ·014	·0040 ·0031 ·0023 ·0026	·017 ·017 ·017 ·016	·0023 ·0025 ·0017 ·0022
400 ..	200 A 200 B	·015 ·015	·0057 ·0051	·010 ·010	·013 ·013	·023 ·023	·0050 ·0045	·015 ·013	·0175 ·0169	·0232 ·0232	·0110 ·0105
200 ..	100 A 100 B	·015 ·015 ·015 ·016	·0051 ·0047 ·0052 ·0052	·010 ·011 ·011 ·011	·010 ·0097 ·011 ·011	·019 ·019 ·022 ·021 ·022	·0039 ·0039 ·0045 ·0045 ·0048	·015 ·014	·011 ·011	·024 ·023 ·021 ·021	·0079 ·0089 ·011 ·011
200 ..	150 A 50 B	·014 ·014	·0028 ·0032	·012 ·013	·0033 ·0037	·021 ·021 ·021 ·022	·0009 ·0019 ·0015 ·0007	·014 ·015	·011 ·011	·023 ·023	·0061 ·0062
200 ..	50 A 150 B	·013 ·013	·0032 ·0028	·0057 ·0057	·013 ·013	·015 ·016 ·015 ·015	·0063 ·0063 ·0064 ·0064	·013 ·013	·017 ·017	·019 ·019 ·017 ·016	·015 ·015 ·016 ·016
20 + 180 water ..	10 A 10 B	·0073 ·0073 ·0075 ·0075	·0011 ·0013 ·0012 ·0012	·0043 ·0044 ·0043 ·0043	·0091 ·0092 ·0088 ·0088	·0089 ·0089	·0007 ·0007	·0075 ·0074 ·0073 ·0075	·0051 ·0051 ·0047 ·0048	·0094 ·0097 ·0093 ·0094	·0037 ·0039 ·0035 ·0035

* Mono = monochloracetic acid.

A. *Individual Acids.*—The results of varying the concentration show that about 200 c.c. of normal acid solution are sufficient to saturate the wool though only a small proportion of the acid is actually absorbed. The amount absorbed from solutions not sufficient for saturation decreases more with dilution with the weaker organic acids in corresponding solution. This is in accordance with the results of Meyer and Fikentscher (1926).

The absorption of sulphuric acid at saturation is about 25 per cent. more than that of hydrochloric. Were the sulphuric behaving as a monobasic acid the absorption should have been double. The greater absorption has been found with more dilute solutions (pH greater than 2·4) by Elod (1933). In the present work, where the most dilute solutions were $\frac{N}{100}$, the pH of the strong acids would be less than 2·4.

B. *Mixed Acids.*—As might be expected, mixtures of hydrochloric and sulphuric acids behave very like equivalent solution of either single acid, each being absorbed nearly in proportion to its relative concentration.

The proportion of acetic acid absorbed from mixtures with strong acids is much less than corresponds with its relative concentration, but more than would be expected from its relative activity.

Monochloracetic acid shows the most striking variation. Alone it is absorbed to a much greater extent than hydrochloric or sulphuric acids; mixed with these it is absorbed in much smaller proportion.

This work was carried out through a grant from funds provided to the University of Queensland by the Commonwealth Government through the Council for Scientific and Industrial Research.

The authors are indebted to Miss N. McGinn who carried out some of the later experimental work.

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HABITS AND CHÆTOTAXY OF THE LARVA OF ANOPHELES ATRATIPES SKUSE.

By Elizabeth N. Marks, B.Sc., Department of Biology, University of Queensland.

Plate I.

(*Delivered before the Royal Society of Queensland, 27th March,* 1939.)

Although the adult of *Anopheles atratipes* was first described by Skuse (1889), Mackerras (1927) was the first to record the larvæ, the only locality in which he found them being Dunwich, Stradbroke Island, where they were collected in September, 1926.

During September and October, 1938, larvæ of this species were collected from Nudgee, Redcliffe, and Bribie Island, Queensland. At Nudgee they were found in a sluggish, slightly muddy creek with not a great deal of vegetation—a habitat corresponding to that from which Mackerras collected them. At Redcliffe they occurred in a freshwater tea-tree (Melaleuca spp.) swamp with considerably more vegetation. At Bribie Island they were collected from water lying in small depressions in damp, peaty soil under tea-trees. In all cases larvæ of *Anopheles annulipes* Walker and of *Culex annulirostris* Skuse were found in the same habitat, and at Bribie Island these were accompanied by Corethra larvæ.

Mackerras gives a brief description of the distinguishing features of the larva of *Anopheles atratipes*, and states that there is no trace of eyes, and that the palmate hairs are greatly reduced or absent. Preparations of the larvæ collected from the above localities showed an indication of eyes in the form of light areas on the darkly pigmented head, occurring at the normal site for eyes (Fig. 1, E.). Undeveloped palmate hairs also were found with slightly flattened branches.

Gater (1934) says of hair No. 1 of the abdominal segments of anopheline larvæ: "When its branches are flattened, forming 'leaflets,' it is usually called a palmate hair, float-hair or fan, and in descriptions of larvæ the palmate hairs are sometimes said to be 'present' or 'absent' on particular segments. Since the hair is always present on each segment, but simply differs in form, it is considered better always to refer to hair No. 1 as the palmate hair and to describe its form. When this hair is stated to be undeveloped, it means that the branches are filamentous; but when it is said to be fully developed, the presence of complete, flattened leaflets is implied. The branches of the palmate hairs vary in form from filaments, through slightly flattened branches and lanceolate leaflets, to fully developed leaflets. . . . ."

The palmate hairs of *Anopheles atratipes* were seen only with difficulty and were at first overlooked, owing to the fact that in the preparations they were practically transparent.

In view of these important divergences from the original description, in addition to slight variations in other features, it has been deemed advisable to give a full account of the chætotaxy of the larva of

Anopheles atratipes Skuse. The following description, including the numbering of the hairs, follows the plan set out by Gater. This author uses in classification, in addition to the chætotaxy of the head, the structure and arrangement of several groups of hairs on the thorax. Unfortunately, owing to the fact that insufficient specimens were collected of the larvæ of *Anopheles bancrofti* Giles and *Anopheles stigmaticus* Skuse, it was not possible to make a comparison of these features in the related members of the genus *Anopheles*.

Dorsal Hairs of the Head. (Fig. 1.)

A.—On the fronto-clypeus.

Hair No. 1: pre-clypeal; short, incurved, simple hair. Hair No. 2: inner anterior clypeal; placed close together; simple. Hair No. 3: outer anterior clypeal; arise external to and in line with No. 2; length is two-thirds that of No. 2; simple. Hair No. 4: posterior clypeal; arise posterior to No. 3; short, not reaching to the base of No. 3; simple. Hairs Nos. 5, 6, and 7: frontal; arise in a row just posterior to the line of the insertion of the antennæ; bases lie in a curved line; branches numerous. Hair No. 8: sutural (inner occipital); four very fine branches.

B.—On the epicranial plates.

Hair No. 9: trans-sutural (outer occipital); arise well anterior to No. 8; stated by Mackerras to be trifid, but hairs with four branches and with two were also seen. Hair No. 10: antennal; situated slightly basal to the middle of the antenna, on the dorso-lateral surface; fully half the length of the antenna; strongly branched. Hair No. 11: terminal antennal; trifid. Hair No. 12: sub-antennal; just ventral to the insertions of the antennæ; strongly plumose. Hair No. 13: ventral to No. 12; strongly plumose, and equal in size to sub-antennal. Hair No. 14: near the larval eyes; bifid. Hair No. 16: on the maxillary palp, situated at its anterior third; strongly branched.

According to Gater, hair No. 15 is on the side of the head below No. 14. It was not seen in the specimens examined.

Hairs of the Thorax. (Fig. 2.)

The three thoracic segments cannot be distinguished, but are indicated in the diagram by dotted lines.

A.—On the prothorax.

(*a*) Dorsal—

Hairs Nos. 1, 2, and 3 (Fig. 3): the inner, central, and outer hairs respectively of the sub-median prothoracic group; No. 1 is simple; No. 2 is branched and arises from a prominent dark root; No. 3 is simple. Hairs Nos. 4 to 7: in that order from within outwards; No. 4 is long and strongly plumose; No. 5, long and shortly plumose; No. 6, long and sparsely plumose; No. 7, the longest of the group, is strongly plumose.

(*b*) Ventral—

Hair No. 8: long, plumose. Hairs Nos 9 to 12 (Fig. 4): the prothoracic pleural group, consisting of an anterior pair of hairs (Nos. 9 and 10) and a posterior pair (Nos. 11 and 12) which arise from the same large tubercle; the anterior pair is separated from the posterior

pair at the roots by a small, hardened plate arising from the tubercle and produced into a slight spine. Hair No. 9: anterior, dorsal, long, with few branches. Hair No. 10: anterior, ventral, long, simple. Hair No. 11: posterior, dorsal, very short, simple. Hair No. 12: posterior, ventral, long (longer than No. 10), simple. Hair No. 13: short, with simple branches. Hair No. 14: shorter than No. 13, with simple branches.

Gater figures hair No. 0—a minute hair, not easily visible, on the dorsal surface of the prothorax. It was not observed in the specimens examined.

B.—On the mesothorax.

(*a*) Dorsal—

Hair No. 1: short, with simple branches. Hairs Nos. 2, 3, and 4: simple. Hair No. 5: short, with simple branches. Hair No. 6: bifid. Hair No. 7: plumose.

(*b*) Ventral—

Hair No. 8: long, plumose. Hairs Nos. 9 to 12 (Fig. 5): the mesothoracic pleural group. Hair No. 9: long, may be trifid. Hair No. 10: long, simple. Hair No. 11: short, simple. Hair No. 12: long (shorter than No. 10), simple. Hair No. 13: short, with simple branches. Hair No. 14: very short, trifid.

C.—On the metathorax.

(*a*) Dorsal—

Hair No. 1: metathoracic palmate, undeveloped, generally with four branches. Hair No. 2: short, with few branches. Hairs Nos. 3 and 4: simple. Hair No. 5: long, strongly plumose. Hair No. 6: short, bifid or trifid. Hair No. 7: long, strongly plumose.

(*b*) Ventral—

Hair No. 8: long, strongly plumose. Hairs Nos. 9 to 12 (Fig. 6): the metathoracic pleural group. Hair No. 9: long, with few branches. Hair No. 10: long, simple. Hair. No. 11: short, simple. Hair No. 12: long (shorter than No. 10), simple. Hair No. 13: short, usually with three branches.

Hairs of the Abdomen. (Fig. 7, Fig. 10.)

On abdominal segments II. to VIII., Gater figures hair No. 0—a minute hair lying just laterally and posteriorly to the anterior tergal plate. This hair was not observed on the specimens examined.

Segment I.—

Hair No. 1: the abdominal palmate hair; stout base, few branches, undeveloped. Hairs Nos. 6 and 7: the lateral hairs; long, strongly plumose. Hair No. 8 is absent. Other hairs (Nos. 2 to 13) are as shown.

Segment II.—

Hair No. 1: abdominal palmate (Fig. 8). Hairs Nos. 6 and 7: the lateral hairs; long, strongly plumose. Hair No. 8 arises anteriorly to Nos. 6 and 7. Other hairs appear as shown in the figure.

Segment III.—

Hair No. 6: first lateral hair; long, strongly plumose. Hair No. 7 is small and has shifted to the ventral surface. Others as shown.

Segment IV.—

Hair No. 1: abdominal palmate (Fig. 9). Hair No. 6 is shorter and has fewer branches than on the preceding segments. Others as shown.

Segments V. to VII.—As shown in Fig. 7.

Segments VIII., IX., and X.—As shown in Fig. 10.

The hairs on segments VIII. and IX. have shifted in the rearrangement of parts connected with the formation of the spiracular apparatus.

Segment X. (the anal segment)—

The cuticle of this segment is armed with minute spines, densest posteriorly. The saddle hair is long and simple. Outer sub-median caudal hairs slightly hooked. Inner sub-median caudal hairs strongly branched. Anal gills long, of equal lengths.

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EXPLANATION OF PLATE I.

Fig. 1.—Diagram of the dorsal surface of the head capsule of *Anopheles atratipes* larva. Some of the hairs and other structures are marked in completely on one side only. For the numbers of the hairs, refer to the text. A, antenna; C, collar; CF, cephalic fan; E, light patch indicating the presence of an eye; EP, epicranial plate; ES, epicranial suture; FC, frontoclypeus. M1, mandible; M2, maxillary palp; S, sabre-shaped piece on antenna.

Fig. 2.—Diagram of the thorax, showing the chætotaxy of the dorsal surface (right-hand portion of figure) and of the ventral surface (left-hand portion of figure). P, prothorax; MS, mesothorax; MT, metathorax.

Fig. 3.—Sub-median prothoracic hairs (enlarged).

Fig. 4.—Prothoracic pleural hairs (enlarged).

Fig. 5.—Mesothoracic pleural hairs (enlarged).

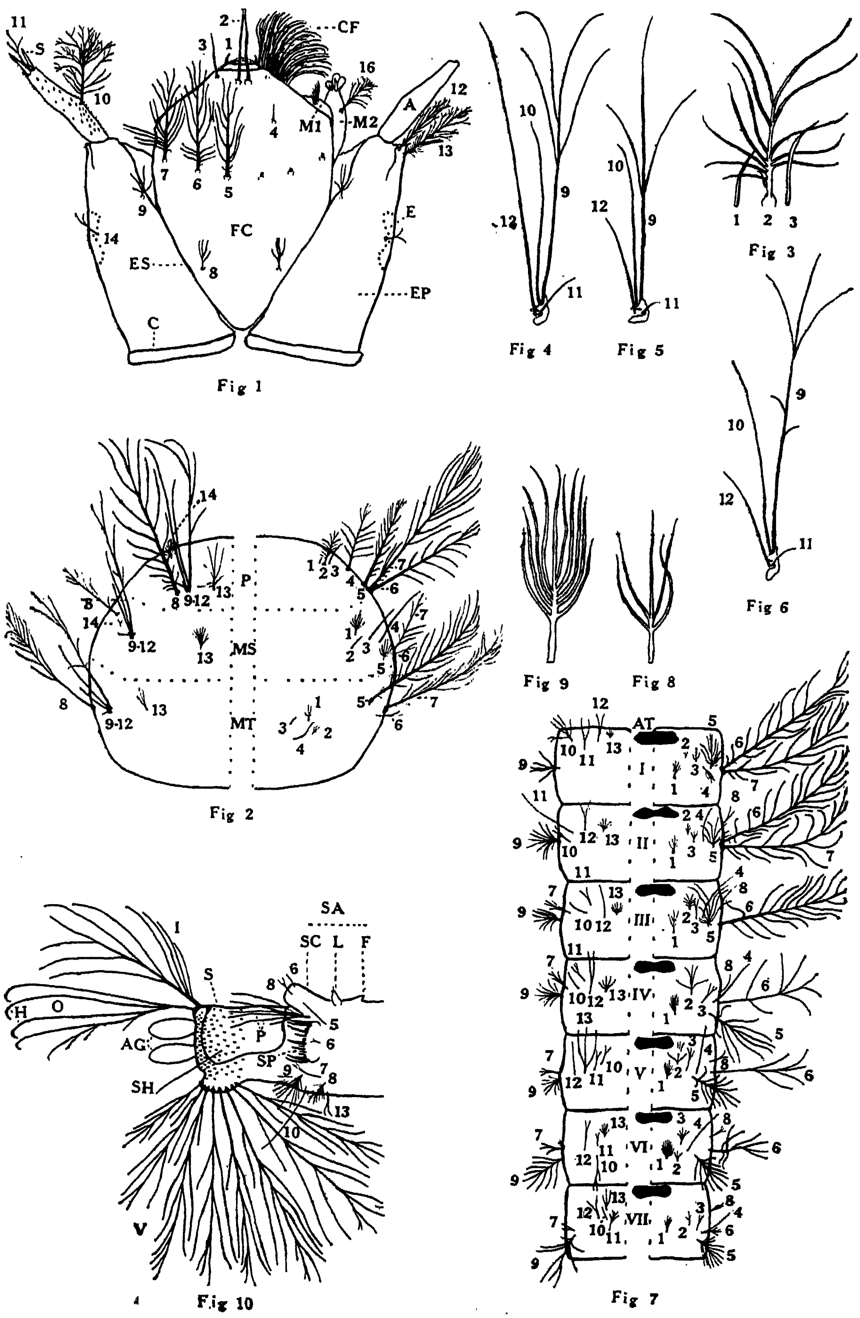
Fig. 6.—Metathoracic pleural hairs (enlarged).

Fig. 7.—Diagram of abdominal segments I. to VII. Right-hand portion shows dorsal hairs; left-hand portion shows ventral hairs. In the mounted specimens the abdominal palmate hairs appeared practically transparent. AT, anterior tergal plate of segment I.

Fig. 8.—Abdominal palmate hair from segment II., x200.

Fig. 9.—Abdominal palmate hair from segment IV., x200.

Fig. 10.—Diagram of the anal or Xth segment of the abdomen, segment IX., and the posterior portion of segment VIII., side view. AG, anal gills; F, fan-shaped plate overhanging spiracles; H, hooks on outer sub-median caudal hairs; I, inner sub-median caudal hair; L, lateral papilla of spiracular apparatus, marking the division between



Setal characters in the Larva of *Anopheles atratipes* Skuse.

segments VIII. and IX.; O, outer sub-median caudal hair; P, post-spiracular hair (No. 9 of segment IX.); S, saddle (anterior tergal plate of segment X.); SA, spiracular apparatus; SC, scoop of spiracular apparatus; SH, saddle hair; SP, spiracular pecten; V, ventral caudal hairs, approximately half the total number being shown; 5 to 10, 13, hairs of corresponding numbers on segment VIII. (anteriorly) and segment IX. (6, 8 posteriorly).

THE INTERRELATIONSHIPS OF THE PLANT COMMUNITIES OF QUEENSLAND.

By S. T. Blake, M.Sc., *Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

INTRODUCTION.

In North-Eastern Australia, approximately that area lying within the boundaries of the State of Queensland, is to be found a wide variety of plant-communities, from very heavy rain-forest to desert, and from mangrove forest to high mountain scrub and moorland. The relationships of many of these communities, both between themselves and to other factors, are particularly interesting, and in this paper it is proposed to offer interpretations to some of these relationships. The communities to be found in the inland areas have been described and discussed in a previous paper (Blake, 1938), the rain-forests have been discussed by Domin (1910) and Francis (1929), but many of the important communities in the region have not yet been satisfactorily described, and some are but poorly known.

GENERAL FEATURES.

The most important factors influencing vegetation in the region are the nature of the soil and available moisture. Soil type is chiefly dependent on rock-type, modified and sometimes controlled by climate in the coastal and subcoastal areas, but apparently almost or quite independent of it in the interior. Topography may also be a modifying factor, but where this does not enter into things the lines of demarcation of soil types and the vegetation types supported thereby are often amazingly sharp. The available moisture depends in some degree on the amount of rainfall, more so on its distribution (mean annual rainfall has comparatively little significance except in extremes, chiefly in the lower end of the scale), on the retentive capacity and the depth of the latter, and on drainage. Rate of evaporation is a powerful modifying factor. Temperature affects the development of communities to some extent, though chiefly as extremes, such as at high altitudes.

One very interesting feature which controls the distribution of the communities of the interior is afforded by the peculiar topography of the country. The slope, and therefore the flow of the rivers is in a general south-west direction towards the centre of the continent. This is almost at right angles to the trend of the isohyets, so that the streams, flowing through progressively drier and flatter country, tend to lose themselves in extensive flood plains. Furthermore, across the direction of flow of these rivers in the middle part of their courses, but not at right angles with them, is a large system of sandstone hills, ranges, and tablelands through which the streams pass, usually by means of valleys of greater or less width, or very occasionally by means of steep gorges. The slopes of these hills are mostly very steep and erosion goes on at a relatively rapid rate, so that after storms and heavy showers a supply of silt is regularly delivered to the main streams to be deposited later over the flood plains of their lower courses.

* Read before Section M, Australian and New Zealand Association for the Advancement of Science, Canberra Meeting, Jan., 1939.

It is on these silt plains, watered by the periodical floods from the rains falling over the upper parts of the watersheds, that there is developed the diversified and economically valuable vegetation of the channel country, consisting of fringing forest, swamps, claypans, and luxuriant herb meadow. The existence of the formation depends, not on the amount of rain falling over the area, but on the water retained in the soil during and after the subsidence of flood waters.

RAIN FOREST.

The antithesis of this is shown by the rain forest or jungle of the eastern coastal belt, chiefly developed in areas where the yearly rainfall is 60 inches or over, more or less evenly distributed, and which are not unduly exposed to gales. Rain forest may be developed in places with a considerably lower rainfall provided that edaphic conditions compensate for this lack, as along stream banks, in sheltered valleys, and upon the deep red loams so characteristic of the basalt-capped tablelands and ranges of the coastal districts. The effect of exposure to sea breezes is well seen near Cape Moreton. Here, with a fairly evenly distributed yearly rainfall of 63 inches but on a shallow sandy soil exposed to every gale, a low shrubbery allied to wallum is developed, scarcely 2 feet high and sometimes lower. The chief woody plants are *Casuarina suberosa* and *Banksia aemula,* species which are normally trees, but are here overtopped by grasses (chiefly *Themeda australis*) though fruiting freely. In less exposed places the shrubs are higher and *Tristania conferta,* a prominent member of the rain-forest ecotone, comes in, firstly as a small shrub.

All rain forest is characterised by a wealth of lianas and epiphytes and the nearly or complete absence of annuals. In the very wet regions the numbers and variety of these epiphytes and lianas are enormous, but in developments in relatively low rainfall they are few, while the characteristic *Hymenophyllaceae* disappear.

The forest canopy usually consists of two or more stories, the net result of which is that the floor is densely shaded, though the individual trees in each story may be relatively widely spaced.

MONSOON FOREST AND BRIGALOW SCRUB.

In regions with a smaller and less equable water-supply, monsoon forest may be developed. Such forest is to be found in places throughout the coastal and sub-coastal areas from at least near the New South Wales border northwards, and in the country surrounding the Gulf of Carpentaria. In the northern parts a pronounced dry winter season and in the south the cold of the winter affects the continuity of the water supply. The communities usually occur on hillsides or hilltops, and in the limestone region in the Chillagoe-Mungana district, they occupy the karst hills as well as granite slopes. As in other community-types in the region, variations in composition occur, and though these are often considerable the general features remain fairly constant. These are essentially an upper story of broad-leaved deciduous or partly deciduous trees, an understory of dense, evergreen, sometimes prickly shrubs and small trees with rather small and hard leaves, one or two somewhat shrubby grasses, and a paucity of lianas and epiphytes. The latter are almost restricted to bryophytes and lichens. The relationships with the open forest in which the communities are often found

are not understood. They often occupy sites apparently similar to others occupied by Eucalyptus forest, yet there is frequently and, perhaps, usually a remarkable absence of ecotone.

Brigalow scrub has usually been regarded as a community of the semi-arid type, but its affinities appear to lie with monsoon forest of which it may be regarded as an extreme phase. The term "scrub" in Queensland is usually applied to a community in which the woody plants grow very close together, and is used irrespective of their size. Thus rain forest and monsoon forest are both popularly referred to as "scrub," sometimes with the distinction of "vine scrub" for the former and "dry scrub" for the latter.

In a well-developed brigalow scrub the trees attain 30 feet or more, and associated are species commonly found in monsoon forests, such as the deciduous trees *Brachychiton rupestre* and *B. trichosiphon*, the smaller hard-leaved evergreens *Canthium vacciniifolium*, *Celastrus* sp., *Capparis nobilis*, and the shrubby grasses *Panicum uncinulatum* and *Eragrostis megalosperma*. The dominant species of the "scrub" are the brigalow itself (*Acacia harpophylla*) which is leafless (phyllodineous) except in the seedling stage, and the belah (*Casuarina lepidophloia*) which has minute scale-leaves only. The richer scrubs differ little from monsoon forest except that the brigalow, with or without belah, replaces one or more of the trees of the upper story of the latter.

Relatively pure stands of brigalow are to be found, and in most such cases the trees are low.

In South Queensland, brigalow scrub is commonly found on a nearly black very heavy soil in which depressions known as "melon-holes" or "gilgais" are numerous and often are of considerable size. Jensen (1921-1922) has claimed that the heavy nature of the soil is due to a relatively high content of sodium carbonate, and has further postulated that brigalow *requires* a soda-rich soil. Many of Jensen's claims can be refuted by evidence from the very area he traversed—Roma and northwards. My own observations would indicate that brigalow has no very particular soil requirements and it is not uncommon to find communities on stony ridges and even on sand. It is, however, quite certain that brigalow scrub is a distinctly aggressive community and will invade and suppress both open forest and grassland. Pure stands of brigalow usually indicate a young community. As the community ages, the nature of the soil changes to the characteristic blackish, heavy, melon-holey soil. When the community invaded was forest on sandy soil this change is very marked. Old stumps of box (*Eucalyptus populifolia*) within tall scrub now indicates areas thus invaded, though various stages can be seen in many localities. Historial records afford further evidence. When grassland is invaded the changes are, as a rule, not so marked, owing to the nature of the grassland soil from which, however, melon-holes are absent. This invasion is proceeding westward into relatively dry areas (within the 15-inch isohyet) and this will be noticed again later.

OPEN FOREST, SPINIFEX COUNTRY, AND WALLUM.

Open forest in some form or other occupies large areas of North-Eastern Australia. The term forest is used here in rather a wide sense and includes the savannah forest, savannah woodland, and woodland of various authors. Owing to the diverse use of the word

"Savannah" it has seemed preferable not to employ it in this connection. Genuine forest certainly occurs in many places, particularly in areas within which rain forest is developed, and not infrequently the canopy is practically closed. Edaphic conditions, possibly assisted by fire, prevent the establishment of rain forest. In the other extreme the trees are scattered and often irregular. The term "parkland" is used to designate this phase, but it is suggested that some such term as "semi-forest" could be employed to designate the very common state of affairs in which the trees are somewhat distant but by no means scattered. As thus employed, the different terms forest, semi-forest, and parkland, have merely a physiognomic significance. In many places all gradations occur with no apparent difference other than tree-frequency.

Open forests are developed chiefly on soils of light texture, though a clayey subsoil may be present. Parkland occasionally occurs on soils of heavier texture, though such are usually shallow and the community is often an ecotone between forest and grassland. Myrtaceae are usually dominant in these forests, commonly species of *Eucalyptus, Melaleuca, Tristania, Angophora,* and *Syncarpia.* Practically all species are evergreen. Towards the North *Grevillea* becomes prominent, likewise a few deciduous trees such as species of *Terminalia* and *Albizzia,* and annual herbs become more numerous.

Towards the drier parts in the South, open forest passes gradually into mulga scrub, and in the wetter parts generally it passes into, or is replaced by, rain forest. If there is a broad ecotone it frequently consists of a tall, almost closed forest of *Eucalyptus grandis* and *Tristania conferta.* Near the rain-forest edge is an undergrowth of shrubs and trees partly belonging to rain-forest species, partly to species almost restricted to the ecotone. If edaphic differences are not too extreme in such cases there is a tendency for the rain forest to advance. In the very wet parts of the north-east edaphic factors are not so important, and rain forest has been advancing rather rapidly within historical times, modifying the nature of the soil somewhat in its progress, chiefly by the addition of humus and the slowing down of leaching processes.

The ecotone, however, is often very narrow, and this is especially seen in many parts of South-Eastern Queensland where a common occurrence is for sandstone or trachyte mountains and tablelands to be capped with basalt. The latter produces a deep red loam which supports rain forest. The sandstone and trachyte give rise to sandy often shallow soils and support open forest. Occasionally an ecotone is present when conditions are modified somewhat by slope or exposure.

More closely allied to the open forests than to any other formation are the majority of the *Triodia*-dominant communities usually referred to as "spinifex country." Much of this spinifex country is merely open forest, chiefly Eucalyptus forest, in which, owing to slight variations in edaphic factors, *Triodia* dominates or partly replaces the usual grasses of the forest floor. Of such a nature is much of the spinifex country in the so-called "desert country" of Central Queensland.* The species of *Triodia,* many of which are undescribed, usually grow on a highly siliceous substrate, either sand or such rocks as sandstone and granite. Occasionally communities are developed on silt beds subject

* This so-called desert is open forest to parkland supported by sandy soils, and much of it is little different in aspect from some coastal communities.

to flooding, and near the Gulf of Carpentaria they extend into swampy areas, the species being associated with coolibah (*Eucalyptus microtheca*) or tea-tree (*Melaleuca* spp.).

Another group of communities, collectively known as "wallum country," occurs along the east coast on sandy soil, consisting of swamps, *Melaleuca* forests, heath-like shrub-lands (wallum flats), and mixed forest. The communities are well known floristically, but their exact relationships are not quite clear. Drainage appears to be an important factor, the succession from wet to dry being open swamp, *Melaleuca* swamp, *Melaleuca* forest, wallum flats, open forest with undergrowth (wallum scrub), open forest with little undergrowth. *Melaleuca* forest is often present only as a narrow band, and one or other of the communities may not be developed. There is sometimes also a tendency to the development of rain forest, either direct from *Melaleuca* swamp or forest, or through wallum scrub.

Related to wallum in floristic composition and physiognomy is a series of communities developed on and near the crest of certain parts of the Great Dividing Range and its offshoots where the underlying rock is granite or sandstone or other highly siliceous rock. What soil there is, is of course sandy, but it is often very shallow and the surface of the ground is often broken and occasionally rugged. One or other species of *Triodia* is often associated and it may well be that the wallum country is the east-coast equivalent of the inland spinifex country.

GRASSLAND AND STEPPE.

The extensive grasslands of the interior are to be found on heavy brown, grey, or black soils, chiefly in areas with a mean annual rainfall not greatly exceeding 30 inches. In the neighbourhood of the Gulf of Carpentaria, broad-leaved deciduous small trees are usually prominent and the communities answer very well to descriptions and photographs of the "orchard country" of Tropical Africa (Tansley, 1926). There is usually a broad ecotone between the communities and the more prevalent open forest. The nature of the soil, dependent on the underlying rock, is the governing factor.

Further south there is practically no ecotone between grassland and forest, and the amazingly sharp division between these formations to the west of the Great Dividing Range in Central Queensland is one of the most remarkable features in the region and what must be one of the most remarkable features of its kind anywhere. Forest trees occasionally stray into the blue-grass country which is found chiefly to the east of the Divide or in the south. In Mitchell grass country, however, if one excepts the ubiquitous gidgea (*Acacia Cambagei*), the few scattered trees which are found in certain places are not trees usually found in forests.

Over much of the grassland areas the rainfall varies considerably from year to year, and this variation sometimes affects the vegetation considerably. But variations occur which are at least partly independent of rainfall. Firstly the annual and ephemeral members of the associations vary in nature and relative frequency from year to year. One year a certain species may be physiognomically dominant, in the following year an entirely different species takes its place, while the former may be rare or virtually absent for some years, and then again suddenly assume dominance. Stocking certainly affects this "seasonal dominance" to a considerable extent but is not entirely responsible for

it, as records indicate that it occurred before settlement took place. Just what are the governing factors is not yet known, though an after-ripening period of the seed, incidence of rainfall, and the soil changes discussed below may be among the most important.

These changes in the frequency of the annual members of the grasslands have a counterpart in the more subtle but profound variations in the perennial composition of the communities. As the result of long-period cyclic changes, there occurs in some districts a fluctuation between blue grass-dominant and Mitchell grass-dominant communities, and in other districts a comparable fluctuation between Mitchell grass-dominant communities and herb-steppe. To these systems the term "fluctuating climax" has been applied, as it is believed that at any given time the community is essentially in equilibrium with its environment (Blake, 1938).

The complete mechanism is not yet clear, but on the evidence available it seems that the changes go on independently of rainfall and stocking, but are influenced by each. The most important factor seems to be bound up with cyclic changes in the nature of the soil, particularly in regard to its salt content. It is now a well-established fact that in soils of arid and semi-arid regions there is a tendency for salts to accumulate in the upper parts of the soil (Vageler, 1933). It is presumed that each of the dominant species, *Dichanthium sericeum*, *Astrebla* spp., and the chenopodiaceous members of the herb steppe, has a definite upper limit of tolerance to salinity. When this concentration is approached in any locality, the dominant species (and the community) is replaced by the community with a higher tolerance. (In the extreme case, salt desert would be produced. This condition is not attained in Queensland, but an approach to it is to be seen in the claypans of the far south-west, and parts of the stony desert are probably comparable). Later, the salt content decreases and the communities of lower tolerance can then establish themselves. Alternes are not infrequent as intermediate stages, but often the changes appear to take place with remarkable suddenness.

Removal of salt could take place either by the removal of the plants themselves, or by the action of water. Heavy showers of rain would wash surface and subsurface salt to lower ground (where claypans so often occur) or down the cracks in the soil itself.

THE DESERT.

In the truly desert parts of the region, there are two very diverse developments. The Stony Desert is little less than the most arid extreme of the gravelly downs with which it is more or less complementary through herb steppe. The sandhill region, commonly known as the Arunta Desert until it was renamed Simpson Desert by Madigan, has been described from various standpoints by different writers (Blake, 1938, Madigan, 1936, and Ratcliffe, 1936, 1937). Whatever may be its origin—and I believe with Madigan that the Desert Sandstone has produced the bulk of the sand—and whatever may be the factors controlling its extent, there seems little doubt that the north-eastern portion is essentially stable. There is no sharp boundary line. Beyond the desert proper, dunes occur to the east and north, either as isolated ridges or as groups of ridges. Those near the desert proper are included in what Ratcliffe has called the "marginal country," but there is a far wider occurrence of these scattered ridges than this, extending eastward as

they do almost to the Great Dividing Range. As their distance east and north from the desert increases, the dunes become smaller and smaller and gradually more widely scattered, until finally they degenerate to mere mounds of sand. There is likewise a progressive change in the vegetation supported by these dunes, passing from the characteristic vegetation of the desert with its *Spinifex paradoxus, Triodia, Acacia ligulata,* &c., and annuals, through hop-bush (*Dodonaea*) and mulga scrub to cypress pine (*Callitris*) forest in the south, and Eucalyptus forest or mixed forest further north. When one considers the apparent stability of the whole, the evidences of considerable age of the dunes in the marginal country, such as their occurrence between river channels and the presence of small lakes within some groups of them, the nature and density of the trees and shrubs upon the isolated dunes, one is forced to the conclusion that these dunes are the remnants of a desert which at one time occupied a much larger area than it does to-day.

And there appears to be no evidence for a present expansion of the desert. The boundaries of this appear to be defined by the direction of the prevailing winds and by river channels. There is no evidence of particular instability at the desert margin either as to sand or vegetation. The facts hitherto adduced as evidence of increasing aridity and desert advance are quite readily explained in other ways. Sandstorms are a natural phenomenon of such regions, and sand accumulates only where there is some obstruction, such as a fence or building. There is no record or other evidence that a new sandhill has been formed elsewhere.

The great rivers of the interior—Cooper's Creek, the Diamantina, the Mulligan—used to pour their flood waters into Lake Eyre, but rarely reach the lake now. This seems to be due to the fact that the flood plains and channel beds are being gradually built up by the normal deposition of silt, so that it is becoming increasingly difficult for the stream, always very slow in this excessively flat area, to force its way along, and it usually loses itself over the plain. The dying-off of trees along the channels, which is so often stressed, may be due in part to old age and partly to this same raising of the river bed further upstream.

Evidence of another nature is afforded by brigalow scrub. It has been shown above that this association is akin to relatively wet-country communities and is at present extending westward. This westward extension would scarcely occur if the interior were drying up.

THE BIOTIC FACTOR.

So far little has been said as to the relationships of the communities to man. In many places settlement has resulted in the complete destruction of the indigenous vegetation, which has been replaced by orchards, farms, artificial pastures, &c. Open forest has often been thinned out to parkland or even grassland by removal of trees, and in hilly country the increased run-off thus induced has resulted in soil erosion becoming a real menace. Soil erosion is even more pronounced where steep hillsides (sometimes originally clad with rain forest) have been given over to banana farms. In the cleared or partly cleared forest country, the herbaceous vegetation is usually more or less modified by the presence of exotic species, sometimes as the result of deliberate planting. Brigalow scrub is being removed in places to make way for argiculture or induced or artificial grassland. In pastoral districts, the white man's introduced animals are affecting the vegetation to a greater or less

extent, and where overstocking has been common, definite communities have resulted. The primitive communities react to stocking in such diverse ways that it would require much more time to discuss them than is available. From an economic point of view, the changes wrought by heavy stocking are not always adverse. Definite improvement in pasture has been noticed to result from heavy stocking in some districts. Extremely adverse reactions are to be observed along stock routes, and it would seem that in many cases these are due to salt-poisoning as the result of the excessive manuring and urination the ground receives as much as to trampling and over-grazing.

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NOTES ON AUSTRALIAN CYPERACEAE III.

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In this paper there is presented a continuation of the work commenced some few years ago on the revision of the Australian Cyperaceae, and upon which three papers have already appeared.* During this period three important monographs, one on the genus *Cyperus* (sens. lat.) and one on *Schoenus*, both by Dr. G. Kükenthal, and one on *Eleocharis* by Dr. H. K. Svenson, have appeared. In the monograph on *Cyperus* Dr. Kükenthal has done most excellent work on a very difficult group and has undoubtedly paved the way for a better understanding of the genus. Unfortunately, as in so many other monographs prepared in Europe, many of the Australian groups have been unsatisfactorily treated, even making allowance for the omission of many species recently observed. It has been my good fortune to examine at leisure all the major collections in Australia, as well as to study in the field and to collect specimens of the great majority of forms at present known to occur in the continent. For the past two years I have been in close correspondence with Dr. Kükenthal and I wish to pay tribute to his unfailing courtesy and kindness.

Much work still remains to be done on the Australian species of *Cyperus* before a really satisfactory account of the genus can be prepared, and in this paper only some of the new species are described, with notes on others. The same applies to the other genera mentioned.

My sincere thanks are extended to the directors of the various Australian herbaria, through the courtesy of whom I have been able to study a very large number of specimens. All specimens cited have been examined, and the herbaria in which they are deposited are indicated by the abbreviations proposed for international usage by Lanjouw in Chronica Botanica, v., pp. 142-150 (1939). Where there is no special indication, the specimens are in the Queensland Herbarium, Brisbane, where the types of my new species are deposited. Duplicates have been, or are in the process of being, distributed to various herbaria.

Cyperus rupicolus *S. T. Blake* sp. nov. nullae speciei alteri arcte affinis, inter australienses culmis longe foliatis, foliis numerosis longis latisque, glumis deltoideis, stylo stigmatibusque fimbriolato, nuce anguste ovata acuta distinctissima.

Perennis, caespites magnos densissimos virides formans. *Culmi* firmi, erecti vel suberecti vel habitationis causa saepissime subnutantes, acute triquetri, lateribus plani vel leviter concavi (in vivo plani nitidi) crebre striatuli, angulis sub apice saepe scabridis exceptis laevissimi, plerumque 60–100 cm. longi, apice $2\frac{1}{2}$–$4\frac{1}{2}$ mm. lati, per $\frac{1}{3}$–$\frac{1}{2}$ longitudinis foliati sed nodis omnibus basi incrassata sitis. *Folia* 5–12; vaginae herbaceae vel inferiores membranaceae brunnescentes, arctae, triquetrae, tenuiter pluristriatae, plerumque laminiferae, superiores ore postice breviter

* Notes on Australian Cyperaceae I. These Proceedings, xlviii., 89-94 (1937); Notes on Australian Cyperaceae II. These Proceedings, xlix., 154-155 (1938); Monograph of the genus Eleocharis in Australia and New Zealand. These Proceedings, l., 88-132 (1939).

ovatae inferiores truncate, vel infimae fissae; laminae lineares vel inferiores ± lanceolatae, prope apicem gradatim acutatae, subplanae vel marginibus ± arcte revolutae, subrigide herbaceae, virides, creberrime plurinerves, carinatae, carina angusta sursum marginibusque scaberulae ceterae laeves, 6–9 mm. latae, summa culmum superans, inferiores gradatim breviores obtusioresque, infimae saepe brevissimae. *Bracteae* plures, inferiores 6–8, subaequales longissimae, foliis similes sed laxiores, superiores gradatim angustiores scabriores. *Anthela* decomposita, densior laxiorve, pluriradiata. *Radii* gracillimi, compressi, subconcavo-convexi, striati, laeves, e prophyllo usque ad 12 mm. longo ore ± oblique secto orti, 6–8 inferiores subaequales usque ad 18 cm. longi. *Bracteolae* setaceae usque ad 5 mm. longae vel brevissimae. *Radioli* primarii 1-plures, subaequales, approximati, filiformes, usque ad 26 mm. longi; radioli secundarii 0–2, breves vel brevissimi. *Spiculae* brunneae vel sanguineae, 1–3-nim digitatae, patentes, late lineares vel oblongae, obtusae, subcompressae, 7–10 mm. longae, 2·5–3·5 mm. latae, 7–12 florae. *Rhachilla* persistens, subvalida, recta, profunde excavata, marginibus tenuis, exalata. *Glumae* subdense imbricatae, deltoideo-ovatae, subobtusae, mucronatae, apice patulae, leviter 7–9-nerves, carinatae, carina laevi inferne incurva sursum excurva vix vel brevissime excurrente, dorso tenuiter coriaceae margines glabras integras versus hyalinae, 3–3·4 mm. longae. *Stamina* 3 filamenta ligulata, antherae lineares 1·2–1·7 mm. longae, appendice rubra subulata setosa 0·15–0·2 mm. longa inclusa. *Stylus* complanatus tenuis, ca. 1 mm. longus, cum stigmatibus 3 longissimis dense fimbriolatus. *Nux* brunnea lucida, anguste ovata, longe pyramido-acuta, triquetra, vix compressa, angulis acuta, lateribus subplanis punctulata cellulis extimis minutis, 1·5–1·7 mm. longa, 0·7–0·75 mm. lata.

QUEENSLAND.—Moreton District: MacPherson Range: Moran's Falls, Feb., 1912, *White*; Moran's Falls, forming large green tussocks on the exposed top and face of the cliff, ca. 3,000 ft., May 24th, 1937, *Blake* 13000 (Type in Bri.); Lamington National Park, Feb., 1919, *White*; Coomera Gorge, among rocks, 1,000–1,900 ft., October 10th, 1939, *Blake* 14119; Mt. Tenduragan near Numinbah, on exposed sheer rock faces, 1,800–2,000 ft., October 10th, 1938, *Blake* 13856.

This handsome species is very distinct from all other Australian species, and indeed from any other species I have seen. Dr. Kükenthal has suggested an affinity with the African *C. derreilema* Steud. among the *Diffusi*, a species which I have not seen, but it differs from that section in that the leaves have only one and not three prominent nerves, in the shape of the glumes, and apparently also in the very long uppermost leaf-sheath and fibriolate style and stigmas.

Cyperus semifertilis *S. T. Blake* sp. nov. inter sect. *Incurvos* Kükenth. ponenda et *C. filipedi* Benth. et *C. disjuncto* C. B. Clarke affinis, sed ab hac anthela normali haud disjuncta, radiis filiformibus elongatis, nuce glumam adaequante vel subsuperante; ab illa habitu, foliis caulinis pluribus bene evolutis, anthelae bracteis radiisque paucioribus; ab utraque spiculis viridibus pallescentibusve androgynis vel nonnunquam masculis differt.

Rhizoma horizontaliter repens, ramosum, lignosum, in intervallis brevibus culmos florentes agens. *Culmi* 30–55 cm. alti, graciles, stricti, acute triquetri, marginibus acutis scaberulis exceptis glabri laevesque.

Folia 4–7 culmi basi sita, graminea, herbacea, plana vel marginibus ± revoluta, linearia, apicem versus gradatim acutata, basi haud angustata, carinata et crebre plurinervia, carina marginibusque sursum scaberulis exceptis glabra laeviaque, 2·5–4 mm. lata, superiora culmum longe superantia, inferiora gradatim breviora; vaginae purpureae, inferiores elaminatae. *Anthela* simplex, laxa, pauciradiata; *bracteae* 2–3, foliis subsimiles sed angustiores, 1–2 anthelam longe superantes, ima basi suberecta; *radii* (ima a ceteris rarissime distans) 1–3 inaequales, usque ad 5 cm. longi, triquetro-filiformes, glabri laevesque, spica centrali haud raro prominule pedunculata, vel raro anthela ad spiculas 1–3 digitatim confertas in apice culmi redacta. *Spiculae* in apice radiorum 1–6 digitatim confertae, virides vel stramineae, lineari-lanceolatae ± acuminatae vel lineares, vix compressae, plerumque 6–14 mm. vel raro usque ad 20 mm. longae, 1·2–2·5 mm. latae. *Rhachilla* persistens, rigida, recta, profunde excavata, exalata. *Glumae* spissae, ovatae, obtusae, brevissime cuspidatae vel submuticae, herbaceo-membranaceae, concavae, haud carinatae, apicem versus incurvae, 9–13-nerves, 1·6–1·7 mm. longae, 1–2 imae vacuae, 4–9 succedentes florem hermaphroditem ceterae florem masculinum foventes, vel nonnunquam flores omnes masculi. *Stamina* 3; filamenta linearia ligulata, inferne paullo angustata; antherae oblongo-lineares, apice minute setosae, 0·8–1·1 mm. longae. *Stylus* brevis latusque, 3 mm. longus; stigmata 3 duplo longiora. *Nux* brunnea, vix nitida, elliptica, apice subpyramidata minute vel vix apiculata, trigona, a dorso admodum compressa, angulo dorsali haud distincto lateralibus ± acutis, lateribus convexula vel subplana, minute punctulata cellulis extimis hexagonis minutis admodum prominulis, glumam subsuperans, 1·6–1·7 mm. longa, 1 mm. lata.

QUEENSLAND.—Moreton District: Mt. Tamborine, in *Tristania conferta–Eucalyptus grandis* forest, 1,300 ft., forming small green patches, June 1st, 1937, *Blake* 13078 (Type in Bri.).

Readily distinguished from all other Australian species of the genus by the somewhat acuminate androgynous spikelets, the male part of which is pale brownish and the lower hermaphrodite part green. It somewhat resembles *C. trinervis* R. Br. of the *Graciles* in general appearance but the latter is densely tufted, the glumes are 3-nerved and keeled, and the nut is much smaller. It shares with *C. disjunctus* R. Br. the pecularity of having the one or two lowermost (true) glumes quite empty.

(Since this paper went to press this species has been collected in two further localities in the Moreton District, namely: Springbrook, in *Tristania conferta* forest on steep hillside, 1,100-1,900 feet., 8th October, 1939, *Blake* 14118; Mount Glorious, very common at edge of rain-forest in *Tristania conferta*—dominant forest, 1,500-2,200 feet; or among rocks on creek banks in fringing forest, extending down to 700 feet, at least on south-western slope, 31st December, 1939, and 1st January, 1940, *Blake* 14126. Except that a few specimens in the latter collection have leaves as narrow as 1.5 mm., the material matches that of the type.)

Cyperus sculptus *S. T. Blake* sp. nov. inter sect. *Graciles* C. B. Clarke ponenda et *C. gracili* R. Br. affinis, sed habitu admodum graciliore, spiculis angustioribus, nuce ellipsoidea laxe reticulata differt.

Perennis, viridis, dense caespitosa, rhizomate brevissimo. *Culmi* setacei, trigoni sed angulis striati, glabri laevesque, usque ad 25 cm. longi (rarissime longiores), erecti vel patentes. *Folia* caulina pauca, basi culmi sita, eorum vaginae tenues, inferiores ± scariosae, brunneae, elaminiferae, superiores 1–2 laminiferae; laminae carinatae, plerumque convolutae, (applanatae) 0·6–0·8 mm. latae, facie superiore praeter

carinam prominule 2–4-nerves, facie superiore enerves marginibus incrassatae, prope apicem subacutam marginibus nervisque minute scabridulae, culmo fere semper multo breviores, raro usque ad 8 cm. longae, nonnunquam brevissimae vel ad mucronem redactae. *Bracteae* 2–3, inaequales, foliis similes, 2 inflorescentiam longe superantes, ima usque ad 9 cm. longa. *Spiculae* 1–10 in apice culmi digitatim confertae, lineari-oblongae vel lineares, obtusae, subcompressae, marginibus serrulatae, virides vel fulvo-tinctae, plerumque 7–10 mm. longae, 1·8–2·2 mm. latae, 14–20-florae. *Rhachilla* persistens, subvalida, recta, valde applanata, profunde excavata, marginibus tenuis sed haud alata. *Glumae* subdense imbricatae, apice patulae, ovatae, obtusae, cuspidatae, carinatae, carina crassa in mucronem brevem excurvum excurrente, in utroque latere membranaceae, pallidae, valide 3–5-nerves, margines versus albo-hyalinae, 1·6–1·9 mm. longae. *Stamina* 3, antherae parvae, lineares, apiculatae, 0·4 mm. longae. *Stylus* brevis, 0·35 mm. longus, stigmatibus 3 longioribus. *Nux* late ellipsoidea, utrinque acutata ± acuminata, conspicue trigona, angulis obtusis haud costatis, lateribus leviter concava vel fere plana, omnino brunnea, nitidula, valde laxeque reticulata, cellulis extimis hexagonis majusculis marginibus prominule elevatis, 1 mm. longa, 0·65 mm. lata.

QUEENSLAND.—Port Curtis District; Rockhampton, on alluvial flats in open Eucalyptus forest, March 5th, 1937, *Blake* 12704 (Type in Bri.); near Rockhampton on rocky rather steep slopes of Mt. Berserker in open forest, 300-700 ft., March 4th, 1935, *Blake* 7894. Wide Bay District: near Bundaberg, in and at edge of rain forest, April 25th, 1936, *Blake* 11284. Moreton District: Petrie, in damp shady places near North Pine River, April 10th, 1932, *Blake* 1191; Moggill, Brisbane, by roadside in shade, March 10th, 1934, *Blake* 5279; Northgate, Brisbane, on sandy loam in rather sheltered or damp places, common, December 17th, 1934, *Blake* 7158; Kangaroo Point, Brisbane, January, 1907, *White*; Brisbane, University grounds, a weed of damp places, April 28th, 1932, *Blake* 1208; in rather damp shady places, June 14th, 1932, *Blake* 1348, 1349; Brisbane Botanic Gardens, in rather damp shady places, June 14th 1932, *Blake* 1350; Rocklea Creek, Brisbane, in a damp somewhat shady place, May 30th, 1932, *Blake and Greenham in Herb. Blake* 1305A; Sunnybank, near Brisbane, in damp shady places, December 7th, 1933, *Blake* 4996; Goodna, near Brisbane, on damp shady banks in the ecotone between Eucalyptus forest and rain forest, April 18th, 1932, *Blake* 1199; Ipswich, on Denmark Hill, on grassy slopes on sandy loam, January 24th, 1933, *Cribb*; Mt. Ernest in grassy places at the foothills, October 8th, 1932, *Blake* 1402.

In its very slender habit and narrow spikelets this species has the aspect of *C. mirus* C. B. Clarke but the nervature of the glumes is similar to that of *C. gracilis* R. Br., while the nut is markedly different from both.

Cyperus cristulatus *S. T. Blake* sp. nov. *C. flaccido* R. Br. inter sect. *Graciles* C. B. Clarke affinis, sed glumarum carina sursum alulata cristulataque differt.

Annua, parva, pallide viridis. *Culmi* perpauci caespitosi vel singuli, stricti, 2–9 cm. longi, triquetri sed setacei (usque ad 0·5 mm.

lati), glabri laevesque, saepe ± striatuli, solum basi foliati. *Folia* caulina 1–2, culmum dimidium superantia vel ejus apicem nonnunquam attingentia, angustissime linearia, acuta, glaberrima laevissimaque, facie superiore plana vel fere plana, enervia, marginibus incrassata, facie inferiore carinata, et praeter carinam tenuiter 2–4-nervia, apicem versus triquetra, 0·5–1 mm. lata, vel interdum folia ad vaginam ore obliquam marginibus hyalinam reticulatam redacta. *Anthela* simplex vel subcomposita, vel ad capitulum paucispiculosum redacta; *bracteae* 2 foliis simillimae sed angustiores, inferior erecta anthelam fere adaequans superior spiculas brevior longiorve; *radii* 0–3, ē prophyllo brevi apice bidentata orti, tenuissimi sed triquetri, minutissime scabriduli vel laeves, valde inaequales usque ad 3·5 cm. longi; *radioli* brevissimi vel nulli. *Spiculae* plerumque 2–6-nim digitatae, undique patentes, oblongae, inciso-serratae, obtusae, 3–4·5 mm. longae, 2·1 mm. latae, 8–16-florae, valde compressae, pallide virescentes saepe brunneo-tinctae. *Rhachilla* persistens, leviter flexuosa, applanata, internodis subexcavata, vix alulata. *Glumae* sublaxe imbricatae, patentes, a latere visae oblique ovatae, acutae vel obtusiusculae, applanatae suborbiculares acuminatae, 3-nerves, valde carinatae, carina sursum alulata inciso-cristulataque in mucronem saepe paullo recurvatum excurrente, lateribus inter carinam nervumque herbaceae, ceterum hyalinae, omnino celluloso-reticulatae, 1·15–1·25 mm. longâe. *Stamina* 2, antherae non visae. *Stylus* 0·25–0·3 mm. longus, stigmata 3 sublongiora. *Nux* pallide brunnescens, haud nitida, elliptico-obovata, triquetra, apice obtusissima minute apiculata, basi ± obtusa, angulis angustis haud costata, lateribus leviter concava fere plana, minute crebreque rugulosa, 0·45–0·5 mm. longa, 0·3 mm. lata, toro brevissimo.

QUEENSLAND.—Cook District: Near Chillagoe in damper places in open forest on grey sandy soil ca. 1,050 ft., April 2nd, 1938, *Blake* 13579.

The species was found associated with other small annual *Cyperaceae* and grasses in a community of *Melaleuca* sp. In its erect bract, oblong spikelets, slightly imbricate glumes with somewhat recurved apices, and pale colour it approaches *C. flaccidus* R. Br. closely, but it is smaller in all its parts, and the winged, distinctly cristulate upper part of the keel of the glume is distinctive.

In his monograph of *Cyperus*, Kükenthal has placed *C. flaccidus* R. Br., *C. aquatilis* R. Br., *C. superatus* C. B. Clarke, *C. breviculmis* R. Br., and *C. imbecillus* R. Br. as varieties of *C. trinervis* R. Br. in the section *Graciles* C. B. Clarke. To my mind all are quite distinct from *C. trinervis* while *C. imbecillus* is a form of *C. laevis* R. Br., with unusually elongated rays in the inflorescence. In recent correspondence Dr. Kükenthal has accepted my rearrangement of the forms as given below. Strictly, the annual members placed by Kükenthal as varieties of *C. trinervis* cannot be placed in the section at all unless the circumscription of the latter be widened, as in all cases the nut is less than half the glume, and there is a distinct approach to the *Haspani* through *C. tenuispica* Steud. There can be no doubt, however, that the species are all closely allied, the relationships being indicated in Fig. 1.

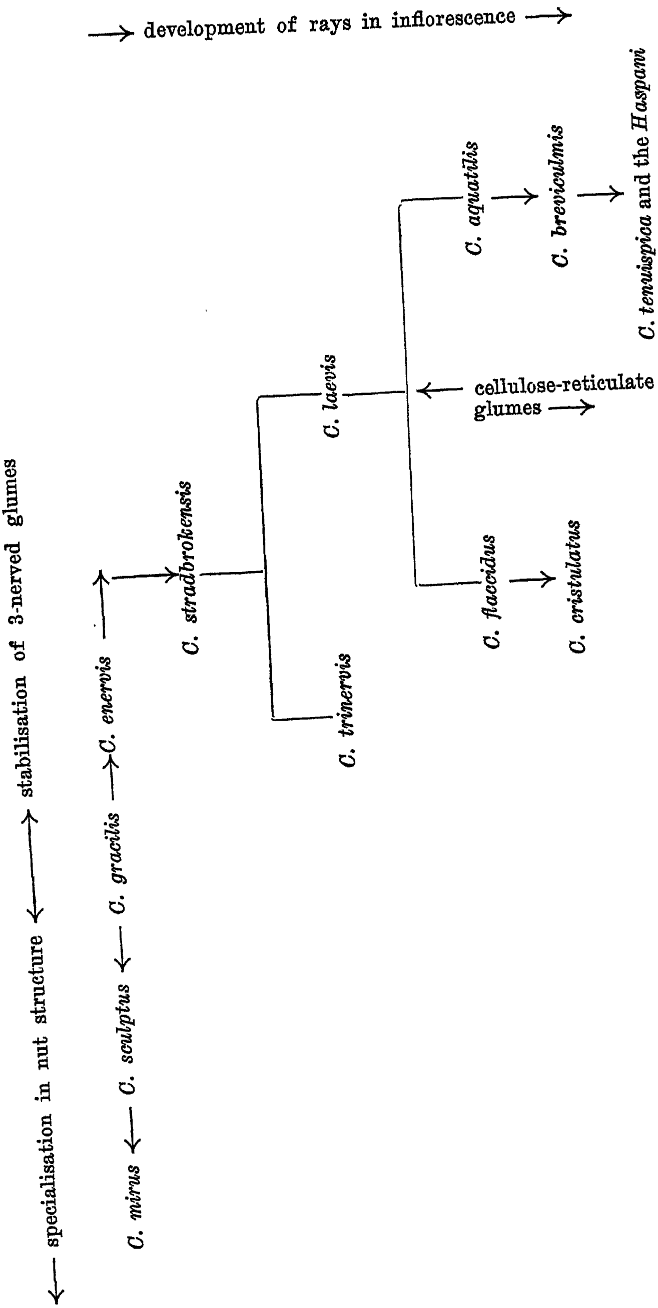


Fig. 1. Phylogenetic table of the *Graciles*.

The species may be distinguished as follows:—

*Perennial; glumes 1–9-nerved, not cellulose-reticulate; nut dark brown or blackish, not tuberculate, equalling $\frac{1}{2}$–$\frac{3}{4}$ glume in length:

- Glumes with one median nerve on each side or nearly nerveless; leaves $\frac{3}{4}$ mm. or more wide, inflorescence often evolute, nut smooth:
  - Nut triquetrous, the sides $\pm$ concave, bracts usually 2, inflorescence often not evolute:
    - Glumes nearly nerveless on the sides, the apex nearly muticous; base of lowest bract setulose on the keel .. .. *C. laevis*
    - Glumes strongly 1-nerved on the sides, the apex mucronate; bracts quite smooth at the base .. *C. stradbrokensis*
  - Nut obtusely trigonous convex on the sides, bracts 3–4, inflorescence always evolute .. .. .. *C. trinervis*
- Glumes with 2–4 nerves on each side or with 1 nerve close to the keel; leaves rarely $\frac{1}{2}$ mm. wide, most usually very narrow; inflorescence always contracted, rays absent; spikelets congested, usually few:
  - Glumes with 1–2 nerves on each side close to the keel, the remainder broad, white and nerveless:
    - Nut smooth or punctulate *C. enervis*
    - Nut striate and trabeculate *C. mirus*
  - Glumes striate throughout with 3–4 nerves on each side:
    - Nut obovate smooth or punctulate, external cells minute .. .. *C. gracilis*
    - Nut elliptical, coarsely reticulate, the hexagonal external cells large .. .. .. *C. sculptus*

*Annual: glumes 3-nerved, cellulose-reticulate; nut white or pale brown, tuberculate, as long as $\frac{1}{3}$-$\frac{1}{2}$ glume:

- Keel of glumes winged and serrulate in upper part .. .. *C. cristulatus*
- Keel of glume neither winged or serrulate.
  - Nut 0·7–0·8 mm. long.
    - Glumes with a rather long recurved mucro, usually pallid; bract almost always 1, $\pm$ exceeding the inflorescence .. .. .. *C. flaccidus*

Glumes acute, or with a very short erect point, mostly tinged with brown; bracts usually 2, shorter than the inflorescence .. .. *C. aquatilis*

Nut 0·5 mm. long .. .. .. *C. breviculmis*

ENUMERATION OF SPECIES.

1. **C. laevis** *R. Br.* Prodr. 213 (1810). *C. imbecillus* R. Br. l.c. 213. *C. enervis* R. Br. var. *laxus* Benth. Fl. Austr. vii. 266 (1878). *C. trinervis* R. Br. var. *laxus* (Benth.) Kükenth. in Pflanzenreich Heft. 101, 293 (1936).

South-east Queensland (Port Curtis, Wide Bay, Moreton, Eastern Darling Downs districts) and North-eastern New South Wales.

In the prevailing form, the inflorescence is in the form of a compound head, a few rays being developed but very short. At times the rays may attain 2–3 cm. in length; this is *C. imbecillus, C. enervis* var. *laxus,* and *C. trinervis* var. *laxus.* In depauperate states there may be no trace of the rays. The two extremes may be found on the same plant.

2. **C. stradbrokensis** *Domin* in Biblioth. Bot. xx. Heft. 85, 422 (1915).

South-east Queensland (Moreton District, on rather loose sand near the sea).

As in the case of nearly all other species described by Domin, it has been necessary to examine carefully his type-localities for the elucidation of the species described by him. Requests for the loan of his types have been ignored by him.

3. **C. trinervis** *R. Br.* Prodr. 213 (1810), and incl. var. *compactus* Domin in Biblioth. Bot. xx. Heft 85, 633 (1915). *C. Lessonianus* Kunth, Enum. pl. ii. 29 (1837). C. *gracilis* var. *? rigidella* Benth. Fl. Austr. viii. 266 (1878) in part.

Queensland and New South Wales in coastal districts. More robust than the other species.

4. **C. enervis** *R. Br.* Prodr. 213 (1810). *C. debilis* R. Br. l.c. 213. *C. enervis* R. Br. var. *fallax* Domin in Biblioth. Bot. xx. Heft 85, 421 (1915). *C. gracilis* R. Br. var. *enervis* (R. Br.) Kükenth. in Pflanzenreich, Heft 101, 297 (1936).

Eastern Queensland (coastal and sub-coastal) and North-eastern New South Wales; also, according to Kükenthal, in New Caledonia.

I have seen no authentic specimen of *C. debilis* R. Br. and no mature specimen agreeing with Kükenthal's description of the species. Through the courtesy of Sir Arthur Hill, I have been informed that Brown's specimen at Kew is undeveloped *C. enervis* and it is chiefly on this authority that I have united the two species. Kükenthal's description agrees fairly with immature plants of *C. enervis* growing in less shady places than this species usually inhabits. Bentham's description (Fl. Austr. vii. 266) refers chiefly at least to the next species.

5. **C. mirus** *C. B. Clarke* in Kew Bull. Add. Ser. viii. 4 (1908). *C. debilis* sec. Benth. Fl. Austr. vii. 266 (1878) not of R. Br., at least in part.

Queensland (Cook District at altitudes of 2,200–2,500 feet., Wide Bay and Moreton Districts) and North-eastern New South Wales as far south as Sydney.

Resembles the former in the broad white margins to the glumes which are nerved only close to the keel, but the spikelets are narrower and the nut is unique with its transversely elongated very prominent external cells.

6. **C. gracilis** *R. Br.* Prodr. 213 (1810).

Queensland (except the far interior and the north-west) and New South Wales as far south as Sydney, chiefly in coastal districts.

7. **C. sculptus** *S. T. Blake* in Proc. Roy. Soc. Queensl. li. 34 (1940).

See above.

8. **C. cristulatus** *S. T. Blake* in Proc. Roy. Soc. Queensl. li. 35 (1940).

See above.

10. **C. flaccidus** *R. Br.* Prodr. 213 (1810). *C. trinervis* R. Br. var. *flaccidus* (R. Br.) Kükenth. in Pflanzenreich, Heft 101, 294 (1936).

Northern Territory, Queensland, New South Wales, Victoria, in wet places. Not known from the interior. Also in Japan and Korea accord- to Kükenthal, who refers to this species *C. macellus* Kunth. Enum. Pl. ii. 30 (1837) and *C. hakonensis* Franch. & Sav. Enum. Pl. Japon. ii. 105 and 538 (1879).

This species appears to be rare in Australia. In the field it can usually be distinguished by its characteristic pallid green colour. It and the two following species were included by Bentham in *C. trinervis*.

11. **C. aquatilis** *R. Br.* Prodr. 213 (1810). *C. inundatus* R. Br. l.c. 213. *C. superatus* C. B. Clarke in Kew Bull. Add. Ser. viii. 4 (1908). *C. trinervis* R. Br. var. *aquatilis* (R. Br.) Kükenth. in Pflanzenreich, Heft 101, 294 (1936), and var. *superatus* (C. B. Clarke) Kükenth. l.c. 294.

Western Australia (Kimberley Division), North Australia, Queensland, New South Wales, and Victoria, in wet places and chiefly in coastal districts.

C. superatus C. B. Clarke, to judge from a specimen of the type collection in Herb. Melbourne (Darwin, *Schultz* 313) is merely a form of *C. aquatilis* with an unusually long bract but the inflorescence not yet fully developed. *C. inundatus* is a small state. What appear to be specimens of the type collection of *C. aquatilis* (New Holland, *Banks and Solander*) are in Herb. Melbourne and Herb. Sydney.

12. **C. breviculmis** *R. Br.* Prodr. 213 (1810). *C. trinervis* R. Br. var. *breviculmis* (R. Br.) Kükenth. in Pflanzenreich, Heft 101, 294 (1936).

North Queensland.

Until recently only known from the type-collection (Carpentaria *R. Brown* 5912) which is represented in Herb. Brisbane (ex Herb. Kew) and Herb. Melbourne. In 1938 I was fortunate enough to secure two excellent series from the Cook District (near Mareeba in dried-out

depressions in *Eucalyptus* forest ca. 1,700 feet, March 28th, 1938, *Blake* 13481; and about 40 miles north-west of Mungana in *Melaleuca* forest on fine whitish sand, April 8th, 1938, *Blake* 13719). Specimens of the former collection match those of the type exactly, but the latter consists of much smaller but older plants mostly not exceeding 5 cm. in height, but with rather elongated spikelets.

Cyperus teneriffae *Poir.* in Lam. Encycl. vii. 245 (1806). *C. calcicolus* Domin in Biblioth. Bot. xx. Heft 85, 632 and plate xvii. figs. 10-13 (1915). Domin's species was omitted from Kükenthal's monograph, and no specimens agreeing with Domin's description and figures were extant in any Australian herbarium. However, in March, 1938, I was fortunate enough to rediscover the plant at the type locality (Cook District: Lion's Head Bluff, Chillagoe, among boulders and in crevices on rugged limestone ridges, ca. 1,150 feet, *Blake* 13519) and specimens were sent to Dr. Kükenthal for an opinion. He has determined them as *C. teneriffae* Poir. forma *petraeus* (Hochst.) Kükenth. and they agree closely with his figure and description of the species, which ranges through Eastern Africa to India, and has very likely been introduced to Queensland. The forma *petraeus* is most probably an epharmone. At Chillagoe the plants were observed on one only of the numerous karst hills ("bluffs"), and that is practically within the town itself.

Cyperus nervulosus (*Kükenth.*) *S. T. Blake* stat. nov. *C. pumilus* L. var. *nervulosus* Kükenth. in Pflanzenreich, Heft 101, 378 (1936). *C. breviculmis* sec. F. Muell. Fragm. viii. 267 (1874) not of R. Br. *C. pumilus* sec. Benth. Fl. Austr. vii. 258 (1878) not of L. *Pycreus pumilus* var. *punctatus* Domin in Biblioth. Bot. xx. Heft. 85, 417 (1915), not *C. punctatus* Roxb.

Northern Australia, North-east Queensland.

Distinguished from all forms of *C. pumilus* by the distinctly nerved sides of the spathulate-oblong glumes. The type-collection (*Dietrich* 618, from Rockhampton) is represented in the Herb. Mel. Typical *C. pumilus* is known in Australia from two localities only (QUEENSLAND: Kennedy North District: Townsville, in open damp sandy places, ca. 5 feet, June 7th, 1934, *Blake* 5978, and Cook District: Cairns, on wet sandy forest land, ca. sea-level, June 15th, 1935, *Blake* 9392).

C. flavescens *L.* Spec. Pl. ed. 1, 46 (1753). The typical form of this has been found in Queensland in the following localities, possibly as introductions:—

Moreton District: Buderim, in swamp, Feb. 24th, 1934, *Blake* 5186; Darling Downs District: Ballandean, on wet sandy places near creek, Jan. 31st., 1938, *Blake* 13237; Wyberba, in swamps, 2,500–3,000 feet, Jan. 21st, 1933, *Blake* 4597; between Bald Mountain and Wyberba, on damp ground on creek bank, Jan. 16th, 1933, *Blake* 4513.

Widely distributed throughout the warmer parts of the world. The specimens referred by Bentham to this species are pale-coloured specimens of *C. sanguinolentus* Vahl.

C. sanguinolentus *Vahl*, Enum. Pl. ii. 351 (1806). *C. Eragrostis* Vahl l.c. 322, Benth., &c., not of Lam. *C. areolatus* R. Br. Prodr. 216 (1810). *C. flavescens* sec. Benth. Fl. Austr. vii. 259 (1878), not of L. *C. sanguinolentus* Vahl var. *areolatus* (R. Br.) Kükenth. in Pflanzenreich, Heft 101, 338 (1936). *Pycreus sanguinolentus* (Vahl) Nees in Linnaea ix. 283 (1835).

Widely spread over Eastern Africa, Southern Asia, East Indies, and the Australian mainland.

Kükenthal has shown (l.c. 115) that the name *C. eragrostis* properly belongs to the plant widely known as *C. vegetus* Willd., a species introduced to New Zealand, Victoria, and New South Wales. He distinguishes the Australian specimens of *C. sanguinolentus* as var. *areolatus* (R. Br.) Kükenth. solely by the blackish margins to the glumes, a character which is very inconstant even in the same inflorescence. His forma *setacea* is merely a small slender state.

C. Luerssenii *Boeck.* in Flora, lviii. 86 (1875), Kükenth. l.c. 426. I have seen specimens from the type collection of this species and of *C. subulatus* R. Br., and cannot distinguish between them. Neither the degree of leaf-development nor the slight difference in the nervature of the glumes emphasised by Kükenthal are constant, and all combinations may occur on the same plant. Hence I would regard *C. Luerssenii* Boeck. as a synonym of **C. subulatus** R. Br. In this species the spikelets may fall entire at maturity, or the glumes may fall singly from a persistent rhachilla, thus combining the features of *Eu-cyperus* and *Mariscus*. In this case also, both states may be observed on one and the same plant either in the herbarium or in the field.

I have seen no authentic specimen of *C. subulatus* var. *confertus* Benth. Fl. Austr. vii. 281 (1878), but the description matches parts of many plants of typical *C. subulatus* where the inflorescence is reduced to a ± compound head.

C. cyperinus (*Retz.*) *Suringar* var. **scabriculmis** *Kükenth.* l.c. 520. An examination of the type-collection in Herb. Sydney (Queensland: Cairns, August, 1901, *Betche*) has shown this to be a depauperate plant of **C. scaber** (R. Br.) Boeck. Normally this species has tall culms with a compound or somewhat decompound inflorescence, and is very different in aspect from *C. cyperinus* (Retz.) Suringar. Small specimens, such as are more usual in South Queensland, where *C. cyperinus* does not occur, have frequently a simple anthela. The two species may be constantly distinguished as follows:—

C. cyperinus.	*C. scaber.*
Culms smooth	Culms scabrous to very scabrous, at least in upper part
Leaves and bracts rather flaccid, not septate-nodulose, mostly flat	Leaves and bracts rather rigid, indistinctly septate-nodulose, margins ± distinctly revolute
Nut oblong, 2·1 mm. long, 0·65 mm. wide	Nut linear-oblong, 2·3-2·5 mm. long, 0·65 mm. wide
Rhachilla not very rigid	Rhachilla rather rigid
Wings membranous	Wings firm, thinly coriaceous

Sect. **Pinnatae** *Kükenth.*

This section was erected by Kükenthal to include a most difficult series of endemic Australian forms. Though placed by the author in the subgenus *Mariscus* the first three species enumerated (*C. angustatus*

R. Br., *C. dactylotes* Benth., and *C. Gilesii* Benth.) are typical *Eu-cyperus* in structure, while most of the other species combine the characters of both subgenera as described above for *C. subulatus*. Kükenthal's arrangement of the forms and his key to them is very unsatisfactory, and what follows can be regarded merely as some contribution towards a better understanding of this most difficult group.

C. Clelandii *J. M. Black* in Proc. Roy. Soc. S. Austr. xlviii. 253 (1924). The type of this (SOUTH AUSTRALIA: Cordillo Downs, Feb. 25th, 1924, *Cleland*), kindly lent by Mr. Black, shows this species to be conspecific with *C. dactylotes* Benth., a widely spread plant in the drier parts of the Northern Territory, Queensland, New South Wales, and South Australia.

Cyperus Betchei (*Kükenthal*) *S. T. Blake* stat. nov. *C. angustatus* R. Br. var. *Betchei* Kükenth. l.c. 452.

Species distincta, a *C. angustato* R. Br. habitu robustiore, foliis latioribus carina marginibusque scaberrimis interdum septato-nodulosis, spiculis distincte spicatis semper caducis, nitidioribus clarioribusque, rhachilla prominule alata, nuce minus abrupte acuminata valde rostrata distinguenda. Nux rostrata notabilis est.

In the drier parts of Central and Southern Queensland and Northern New South Wales, the type is from Narrabri, collected by Betche in Jan., 1883 (N.S.W., Mel.).

C. rigidellus (*Benth.*) *J. M. Black*, Fl. S. Austr. 676 (1929). *C. gracilis* R. Br. var. ? *rigidellus* Benth. Fl. Austr. vii. 266 (1878) chiefly. *Mariscus rigidellus* (Benth.) C. B. Clarke in Kew Bull. Add. Ser. viii. 18 (1908). *C. subpinnatus* Kükenth. var. *subrigidellus* Kükenth. in Fedde, Repert. xxix. 199 (1931).

While I have not seen Bentham's type, I have seen several authentic specimens of Kükenthal's variety, as well as a large number of others from the interior of Queensland (Warrego District), New South Wales, South Australia, and North-west Victoria. They agree fairly with the descriptions of *C. rigidellus* and differ sharply from *C. subpinnatus* in the less rigid habit, the softer texture of the glumes and the wingless rhachilla. There is a considerable variation in the degree of development of the inflorescence, some culms bearing elongated rays, and in the colour of the glumes.

C. ochroleucus *Boeck.* in Flora lviii. 85 (1875). An examination of the type of this from Herb. Berlin, kindly lent by Dr. J. Mattfeld, has shown it to be a robust specimen in young flower of *C. fulvus* R. Br. var. *densespiculatus* (Domin) Kükenth. with the uppermost leaf-sheath longer than usual. The taxonomic value of this variety is questionable, as in most tufts seen with reflexed secondary rays in the inflorescence, some inflorescences occur without such rays. In other words, *C. fulvus* (typical) and var. *densespiculosus* may occur on the same plant. The species is an exceedingly variable one.

Cyperus perangustus (*Kükenth.*) *S. T. Blake* sp. nov. inter sect *Pinnatos* Kükenth. ponenda et *C. fulvo* R. Br. affinis, a quo anthela majore decomposita laxiore, radiolis semper evolutis, spiculis multifloris angustissimis, rhachilla late alata, nuce elliptica apice haud abrupte acuminata, latere adaxiali distincte curvata differt.—*C. fulvus* R. Br. var. *perangustus* Kükenth. in litt.

Dense caespitosa, viridis, ± viscida. *Culmi* plures, stricti, erecti, graciles, triquetri, striati, glabri laevesque vel sub apice scabridi, 20–40 cm. alti, tantum basi incrassata vaginis latis brunneis multinervis ± resinosis foliati. *Folia* pauca, inter se distantia, vagina summa usque ad 9 cm. longa; laminae lineares, sursum gradatim attenuatae, planae vel inferne complicatae, septato-nodulosae, carinatae et crebre plurinerves, carina marginibusque scabrae, 3·5–5·5 mm. latae, culmi apicem superantes. *Anthela* composita, laxa vel sublaxa, 7–10-radiata; *bracteae* plures, foliis similes superiores gradatim angustiores brevioresque, 3–4 inferiores anthelam superantes vel longe superantes. *Radii* rigidi, undique patentes, inaequales, usque ad 10 cm. longi, compressi, glabri laevesque, e prophyllo ore paullum oblique secto orti; *radioli* ± deflexi, usque ad 3 cm. longi; *bracteolae* ± setaceae, radiolis plerumque brevioribus. *Spicae* breves, e spiculis 4–10 approximatis divaricatis constructae. *Spiculae* aureae vel aureo-brunneae anguste lineares, turgidulae, 7–18 mm. longae, 1·2–1·7 mm. latae, 7–22-florae. *Rhachilla* tenuis, flexuosa, rigida, late alata, decidua vel persistens. *Glumae* sublaxe dispositae, imbricatae, primo appressae tandem aliquantulum patentes, deciduae vel cum rhachilla decidua ± persistentes, ovatae, obtusae vel leviter retusae, tenuiter membranaceae, carinatae, carina viridi recta (a latere visa) brevissime excurrente, latere utroque 3–4 nervis prominule notatae, 1·8–2·1 mm. longae. *Stamina* 3, antherae oblongae obtusae, 0·6–0·7 mm. longae. *Stylus* tenuis 0·8–0·9 mm. longus stigmatibus 3 paullo brevior. *Nux* brunnea ± vernicosa, anguste elliptica, apice rotundata breviter acuminata, obtuse trigona, latere adaxiali curvata concavaque ceteris convexa, cellulis extimis minutis paullo prominulis, 1·5–1·6 mm. longa, 0·5–0·6 mm. lata, gluma paullo vel usque ad ¼ brevior.

QUEENSLAND.—North Kennedy District: Rockingham Bay, Jan. 30th, 1862, *Dallachy* (Bri., Mel.); Townsville, on the mid-slopes of Castle Hill, chiefly in gullies, March 30th, 1935, *Blake* 8359; Magnetic Island, on rocky granite cliff face in light rain forest and in shady places near a creek, March 24th, 1935, *Blake* 8237; and on shady creek bank, *Blake* 8249. Port Curtis District: Gracemere, Feb. 10th, 1876, *O'Shanesy* 1642 (Mel.); Marmor, between Rockhampton and Gladstone, in monsoon forest, March 8th, 1937, *Blake* 12778. Wide Bay District: Near Bundaberg, in mixed open forest on sandy soil, April 26th, 1936, *Blake* 11304 (Type in Bri.).

O'Shanesy's and Dallachy's specimens are immature and were referred by previous authors to *C. angustatus* R. Br. *C. perangustus* differs from *C. angustatus* in its viscidity, in the much broader prominently septate-nodulose leaves, rather loosely spicate spikelets, the broadly winged rhachilla, and in the unsymmetrical nut the edges of which are not parallel.

In a letter Dr. Kükenthal suggested that the form was a variety of *C. fulvus*, giving merely the diagnosis as follows:—Anthela decomposita ampla laxa; spiculae lineares vix 1 mm. latae.

Cyperus clarus *S. T. Blake* sp. nov. inter sect. *Pinnatos* Kükenth. ponenda, affinis *C. fulvo* R. Br. et praecipue var. *confuso* (C. B. Clarke) Kükenth., sed a formis omnibus speciei spiculis latioribus, glumis majoribus in mucronem validum excurvum excurrentibus, nucis majoris fuscae angulis subacutis lateribusque subplanis vel concavis differt.

Perennis, caespitosa, viridis, haud viscida. *Culmi* erecti, stricti, rigidi sed graciles, 15–50 cm. alti, apicem versus scabriduli, ceteri glabri

laevesque, basi incrassata vaginis latis brunneis multi-nervis obtecti. *Folia* pauca, basi culmi sita; laminae lineares, longe acutatae, ± coriaceae, rigidae, culmi apicem saepe attingentes vel superantes, planae vel admodum revolutae vel (praecipue inferne) complicatae, septato-nodulosae, tenuiter plurinerves, carinatae, carina marginibusque irregulariter spinuloso-scabrae, 2·5–6 mm. latae. *Bracteae* 3–5 foliis similes, 2–3 anthelam superantes. *Anthela* simplex vel subcomposita, vel ad capitulum compositum redacta, 0–6-radiata, subdensa; *radii* subrobusti, stricti, ± patentes, trigoni ± compressi, glabri laevesque, e prophyllo tubuloso ore ampliato oblique secto orti, usque ad 4 cm. longi; *radioli* nulli. *Spiculae* plures vel numerosae in capitulis hemisphericis vel subglobosis 20–25 mm. diam. brevissime spicatae, quasi digitatim confertae, leviter compressae, oblongae vel lineari-oblongae, 8–15 mm. longae, 2·7–3 mm. latae, 6–20-florae. *Rhachilla* persistens, haud caduca, leviter flexuosa vel fere recta, rigida, valde applanata, fere exalata. *Glumae* facile deciduae, sublaxae, primo imbricatae demum ± patentes et ob margines ± involventes inter se ± discretae, aureae vel castaneae vel clare brunneae, nitidulae, ovatae, obtusae, rigide membranaceae, margines versus admodum tenuiores subscariosae, carinatae et praeter carinam ± nervosam superne validam sub glumae apice in mucronem validum acutum excurvum 0·4–0·7 mm. longum excurrentem, 6–8-nerves, et mucrone incluso 3·2–3·8 (plerumque 3·3–3·5) mm. longae. *Stamina* 3, antherae lineares, minute apiculatae, 0·6–0·8 mm longae. *Stylus* tenuis, 0·8–1·2 mm. longus, stigmata 3 tenuia paullo longiora. *Nux* fusca vel cinereo-velata, haud nitida, obovato-oblonga, acuminata, subaeque trigona angulis subacutis, latere adaxiali ± concava ceteris plana, 2–2·1 mm. longa, 0·85–0·95 mm. lata, cellulis extimis minutis vix obviis.

QUEENSLAND.—Leichhardt District: Minerva, north of Springsure, in grassland on dark grey clay loam, 800-1,000 feet, March 7th, 1935, *Blake* 7934. Port Curtis District: Gracemere, dry gravelly places, common, Nov. 1st, 1873, *O'Shanesy* 1406 (Mel.). Warrego District: Morven, in depressions in railway enclosure on dull brown silt clay ca. 1,400 feet, April 2nd, 1936, *Blake* 11008. Maranoa District: Mitchell, on bed of Maranoa River on sand, ca. 1,350 feet, May 4th, 1934, *Blake* 5738. Darling Downs District: Palardo, west of Miles, in railway enclosure on black clay, ca. 1,100 feet, May 10th, 1934, *Blake* 5886; Oakey, *Donges* 6 in 1930; Drayton, on hillsides on heavy soil, either in the open or in Eucalyptus forest; also common at edge of cultivation, Feb. 12th, 1934, *Blake* 5174 (Type in Bri.).

NEW SOUTH WALES.—Far Western Plains: Mootwingie, near Broken Hill, in rock pools, Oct. 9th, 1921, *A. Morris* 845(N.S.W.); Goyinga Mountains, near rocky waterholes, Nov. 6th, 1860, *Victorian Expedn.* (Mel.).

? SOUTH AUSTRALIA.—Oodnadatta, June, 1914, *Stair* (Herb. Black); very young with no base, but apparently this species.

So far as observed in Queensland this species is chiefly found on heavy soils. Well-developed specimens are readily known by the dense globose spikes of relatively broad, rather turgid, brightly coloured spikelets with rather prominent recurved mucros to the glumes. In habit it recalls *C. Gilesii* Benth. rather than *C. fulvus* R. Br., but the nut and glumes are much broader, and the plant is a perennial with more prominently thickened culm-bases. From all forms of the variable *C. fulvus* it differs in the dense globose spikes, the broader spikelets of a usually

quite different colour, the prominently cuspidate glumes, the rather sharp angles to the nut, the faces of which are not brown, and the adaxial is distinctly concave and incurved towards the base.

Cyperus oxycarpus *S. T. Blake* sp. nov. affinis *C. carinato* R. Br. in sect. *Pinnatis* Kükenth., a quo vaginis basi culmi induratis nitidis, bracteis plus numerosis, glumis longioribus acutioribusque, nuce lanceolata vel fere lanceolata, apice acuta, differt.

Perennis, dense caespitosa, glabra, haud viscida. *Culmi* stricti, erecti, rigidi, 35–50 cm. longi, 1½–3 mm. lati, obtuse trigoni, crebre striati, sub apice parce scabriduli ceterum laeves, basi vaginis ± squamiformibus duris nitidis striatis purpureis vel purpureobrunneis subincrassati. *Folia* 4–5 culmi basi sita inflorescentiam ipsam longe superantia et eis innovationum saepe exceptis valde septato-nodulosa; vaginae arctae haud carinatae; laminae angustae, apicem setaceam versus longe attenuatae, plerumque complicatae raro ± planae, usque ad 4·5 mm. latae, plurinerves, basin versus exceptae carinatae, carina superne acuta marginibusque scabridae, ceterum laeves. *Bracteae* plures, 3–5 inferiores foliis similes anthelam longe superantes, superiores gradatim breviores angustioresque. *Anthela* composita vel simplex, sublaxa, plerumque 5–10-radiata; *radii* ± robusti, rigidi, stricti, compressi, tenuiter striati, laeves, usque ad 9 cm. longi, suberecti vel admodum patentes, e prophyllo breviusculo apice obliquo orti; *bractcolae* sub-setacei, anthelulam plerumque superantes; *radioli* pauci plerumque breves, raro plus 2 cm. longi, saepe non evoluti. *Spiculae* in capitulis densis saepe compositis 10–15 mm. diam. digitatim dispositae, fulvae vel sanguineo-maculatae, ovatae vel ovato-oblongae, compressae, 8–14-florae, 5–7·5 mm. longae, 4–4·5 mm. latae. *Rhachilla* persistens flexuosa, exalata, tenuis, nodis inter se 0·7 mm. distantibus incrassata. *Glumae* deciduae, oblique patentes, primo ± imbricatae, tandem quoque ob margines involutas inter se discretae, ellipticae, acutae, vel leviter emarginatae et minute apiculatae, membranaceae, leviter carinatae (carina a latere visa leviter curvata), latere utroque nervis validis 3 notatae, 2·8–3 mm. longae, 1·5 mm. latae. *Stamina* 3, antherae lineares, 0·8–1·0 mm. longae, connectivi apice conica 0·1 mm. longa inclusa. *Stylus* tenuis 1 mm. longus, stigmata 3 filiformia subaequilonga. *Nux* straminea nitidula, lanceolata vel oblongo-lanceolata, acuta, trigona, subsymmetrica, a lateribus subcompressa, faciebus convexula vel adaxiali subconcava, cellulis extimis minutis inconspicuis, 2·3 mm. longa, 0·6 mm. lata.

QUEENSLAND.—Cook District: On Wrotham Park, ca. 50 miles north-west of Mungana, at edge of lagoon, April 8th, 1938, *Blake* 13712. Burke District: Wernadinga, between Normanton and Burketown, at edge of lagoon May 31st, 1935, *Blake* 9209 (Type in Bri.); O'Shanassy River, approx. 19° 10′ S., 138° 45′ E., on mud near water, April 19th, 1935, *Blake* 8637.

The nearest ally to this new species is certainly *C. carinatus* R. Br. which, however, has loose leaf-sheaths much softer in texture, and the lower ones without laminae are septate-nodulose like the others, and not hard and shining, the glumes are definitely obtuse, the anthers are smaller, and the nut is oblong and obtuse or abruptly apiculate at the apex. Kükenthal describes the leaves of *C. carinatus* as "haud carinata, convoluta." I find the leaves of both species sharply keeled in the upper

part, the keel becoming more obtuse and less distinct towards the lower part, and finally disappearing completely a short distance above the union with the sheath.

Rhynchospora heterochaeta *S. T. Blake* sp. nov. affinis *R. longiseti* R. Br. a qua spiculis nucibusque minoribus setis hypogynis non plumosis differt.

Annua, viridis. *Culmi* solitarii vel caespitosi, obliqui vel erecti, stricti, usque ad 30 cm. longi, graciles, subacute triquetri, prominule striati, glabri laevesque, enodes. *Folia* plura (usque ad 9) basi culmi sita, inferiorum vaginae ± apertae; laminae lineares, gramineae, submolles, supra medium gradatim acutatae, planae vel raro ± complicatae, anguste carinatae, plurinerves, carina marginibusque superne parce scabrae, ceterum glabrae laevesque, usque ad 3·5 mm. latae, usque ad 15 cm. longae, culmis plerumque breviores vel culmos minores adaequantes vel paullum superantes. *Inflorescentia* terminalis capitata multispiculosa, plerumque 12–20 mm. lata. *Bracteae* foliaceae inaeqales, 4–8 capitulum adaequantes vel superantes usque ad 10 cm. longae, lineari-lanceolatae vel superiores lanceolatae, basi dilatata ecarinata marginibus dense ciliatae superne carina marginibusque scabrae. *Spiculae* aureo-brunneae, lanceolatae, acutae, dorso-ventraliter applanatae, 6–8·5 mm. longae, ca. 1·5 mm. latae, 1–nucigerae. *Glumae* 7, quinta fertilis elliptico-lanceolata, acute acuminata, tenuiter coriacea margines versus hyalina, 1–nervis, 6–7·5 mm. longa; 4 inferiores gradatim breviores obtusiores, ima 1 mm. haud vel vix attingens, penultima florem masculinum fovens et cum summa quam fertili multo angustior, brevior, ± involuta. *Stamina* 2, antherae lineares, anguste apiculatae, ca. 1·5 mm. longae. *Stylus* longus filiformis indivisus. *Nux* brunnea vel fusco-brunnea, obovato-oblonga, dorsoventraliter applanata, lateribus subconcava, marginibus obtussissima haud attenuata linea albida notata, punctulata, per $\frac{1}{3}$–$\frac{2}{3}$ longitudinis superioris pilis spinulosis crassiusculis antrorsim appressis ornata, 3·0–3·7 mm. longa, 1·1–1·3 mm. lata. *Stylobasis* a nuce discreta, elongata, angusta, applanata, basi dilatata crassior, cellulosa, marginibus antrorsim scabra, nucis $\frac{3}{5}$–$\frac{2}{3}$ longa, basi haud constricta $\frac{1}{2}$ nuce lata. *Setae hypogynae* 6, una nuce brevior vel brevissima sublaevis, ceterae subaequales nucem cum stylobasi subaequantes (longiores brevioresve), antrorsim scabrae, basin versus sublaeves vel minute ciliatae, basi ipsa glaberrimae laevissimaeque.

PHILLIPINE ISLANDS.—Luzon: Province of Bulacan, Sept., 1913, *Ramos in Herb. Phil. Bur. Sci.* 2099 (Bri.).

EAST INDIAN ARCHIPELAGO.—Madoera Tusschen Sampang en Rapa, 50 m., March 11th, 1915, *Backer* 20052 (Bri. ex Bz.).

NORTHERN TERRITORY.—Darwin, *Tate* in 1882 (Mel.), *Holtze* in 1886 (Mel.), April, 1927, *Bleeser* 149 (Mel., N.S.W.), without collector's name (Bri., N.S.W.); Point Charles, western side of Darwin Harbour, *Mair* 214.

QUEENSLAND.—Burke District: Normanton, March, 1876, *Gulliver*. Cook District: Biboohra, near Mareeba, on sand in Eucalyptus forest, June 20th, 1935, *Blake* 9541; Cairns, on wet sandy forest land, ca. 0 feet, June 15th, 1935, *Blake* 9375. North Kennedy District: Rockingham Bay, *Dallachy* (Mel.); Cleveland Bay, *Johnson* in 1887 (Mel.). South Kennedy District: South of Mount Christian in grass-tree country, May, 1927, *Francis*. Wide Bay District: Near Bundaberg in Eucalyptus forest, chiefly on lower ground, April 27th, 1936, *Blake* 11322; near

Nikenbah, open sandy places near railway, June 5th, 1932, *Blake* 1323. Moreton District: Virginia, Brisbane, in *Melaleuca* forest, April 14th 1933, *Blake* 4749 (Type in Bri.); in *Melaleuca* forest in low flat country, May 25th, 1932, *Blake* 1297; in railway enclosure, April 2nd, 1934, *Blake* 5303. Also probably Queensland, without definite locality, *Banks and Solander* in 1770 (Mel., N.S.W.).

This species has been confused in Australia with *R. longisetis* R. Br., but it has smaller spikelets and nuts, relatively shorter style-base, and non-plumose bristles. The extra-Australian specimens were distributed as *R. Wightiana* Nees, which has a very different nut and style-base.

There are several externally closely similar annual capitate species of *Rhynchospora* in Australia, but an account of them must be deferred.

Carpha nivicola *F. Muell.* in Trans. Phil. Soc. Vict. i. 195 (1855). This species was founded on very depauperate specimens and has been referred by all later authors to *C. alpina* R. Br. An examination of the material of the genus in Herb. Melbourne has shown it to be a distinct species, and that normal specimens are readily distinguishable from *C. alpina* by the broader leaves (up to 3 mm. wide), the rather larger spikelets and nuts, and the hypogynous bristles plumose to the tips and not simply scabrous in the uppermost part as in *C. alpina*.

The following collections have been seen:—

NEW SOUTH WALES.—Southern Tablelands: Mount Kosciusko, up up to 5,000 feet, Jan., 1895, *Maiden*; Snowy Mountains, *Bäuerlen* 70.

VICTORIA.—Australian Alps, *F. Mueller* (Type in Mel.).

TASMANIA.—Mount Wellington and Hardinger Range, *F. Mueller* ?.

Schoenus foliatus (*Hook. f.*) *S. T. Blake* comb. nov. *Scirpus foliatus* Hook. f. in London Journ. Bot. iii. 414 (1844). *Chaetospora axillaris* R. Br. Prodr. 233 (1810). *Schoenus axillaris* (R. Br.) Poir. Encycl. Suppl. ii. 251 (1811) and of most authors, not of Lam. *Helothrix pusilla* Nees in Ann. Nat. Hist. Ser. i., vi. 45 (1841). *Helothrix axillaris* (R. Br.) Palla in All. Bot. Zeitschr. viii. 68 (1902). *Schoenus subaxillaris* Kükenth. in Fedde, Repert. xliv. 89 (1938).

Queensland (Darling Downs District), New South Wales, Victoria, South Australia, Tasmania, New Zealand.

Though I have not seen Hooker's type, his description could only refer to this species. The New Zealand specimens I have seen are identical with the Australian ones. In recent correspondence, Dr. Kükenthal has accepted the above view.

Schoenus Kennyi (*F. M. Bail.*) *S. T. Blake* comb. nov. *Arthrostylis Kennyi* F. M. Bail. in Queensl. Agr. Journ. xxviii. 278 (1912).

The species is certainly a *Schoenus* but the unusually white spikelets of the type specimens arranged in dense heads, the obscurely distichous nature of the lowermost glumes, the 6 stamens, and the poorly developed leaves appear to have misled Bailey into placing the species in *Arthrostylis*. The stems sometimes bear two somewhat distinct heads of spikelets, and there is also frequently a node in the upper part. The leaves are reduced, but mostly obvious. The white colour of the glumes is less prominent in the more southern specimens and is sometimes

replaced by brown. Its nearest ally is *Sch. subaphyllus* Kükenth. [*Sch. aphyllus* Boeck. (1874) non Vahl. (1806)], a species widely spread in the drier parts of the continent, and the two may be distinguished as follows:—

Culms nodeless, leaf-sheaths always deeply split or quite open and often separating from the culms, leaves reduced to points or quite absent; nut elliptic or oblong-elliptic, strongly and rather abruptly constricted at the base, rounded at the apex, not at all ribbed except at the very base, smooth, rather tawny and spotted with red, 2·5 mm. long .. .. .. *Sch. subaphyllus*

Culms usually 1–noded, the uppermost basal sheath closed almost to the top, or if more deeply split then tightly convolute, laminae always obvious, often rather well-developed; nut 1·8 mm. long, oval or somewhat obovate, narrowed at the base, the apex somewhat pyramidal, rather prominently 3–ribbed, the sides brown or brownish and wrinkled .. .. *Sch. Kennyi*

Specimens examined of *Sch. Kennyi*:

QUEENSLAND.—North Kennedy District: Herberton, Jan. 1912, *Kenny* (Type in Bri.), Dec., 1912, *Kenny*, Dec., 1911, *Kenny;* Jan., 1918, *Michael*; west of Pentland between Warrigal and Burra on slopes of Great Dividing Range on shallow sand overlying sandstone, 1,500–1,650 feet, October 10th, 1935, *Blake* 9946. Darling Downs District: 9 miles east of Condamine on ridge-top in *Eucalyptus decorticans* —*E. nubilis* forest on shallow grey hard fine sandy soil, ca. 1,100 feet, Feb. 19th, 1938, *Blake* 13305.

NEW SOUTH WALES.—Central Western Slopes: Dubbo, Jan., 1898, *Boorman* (N.S.W.).

Uncinia flaccida *S. T. Blake* sp. nov. affinis *U. nervosae* Boott et *U. compactae* R. Br., ab hac utriculi basi attenuata nec rotundata, foliis angustioribus, ab illa utriculo latiore foliis flaccidis, ab utraque spica laxiore foliis multo longioribus differt. Ab *U. riparia* R. Br. foliis paullo angustioribus, spica breviore, glumis 3–5-nervis utriculum subaequantibus et ab *U. rupestri* Raoul glumarum utriculorumque forma nervaturaque recedit.

Dense caespitosa, laxiuscula, viridis. *Culmi* 20–40 cm. longi, gracillimi, molles, acute triquetri, angulis sursum $\pm$ scabridis exceptis laeves, striati. *Folia* 5–7, culmi basin versus sita, culmum superantes vel longe superantes; vaginae tenues, inferiores pallide brunneae; laminae angustissimae, molles, planae, 3–5-nerves, leviter carinatae, 0·6–1·5 mm. latae, supra medium longe attenuatae et carina marginibusque parce scabridae, ceterum glabrae laevesque. *Spica* oblongo-lineares vel lineares, 18–30 mm. longa, laxiuscula, pars dimidia mascula. *Glumae* inter se plerumque 2–2·5 mm. distantes, ovatae, tenuiter membranaceae, 3– vel sub–5-nerves, dorso virides tenuiter carinatae, lateribus late enerves, $\pm$ hyalinae vel fusco-tinctae, 4·5–5 mm. longae, masculae apice obtusa, femineae sursum angustatae sed apice ipsa anguste rotundatae, utriculum adaequantes vel fere adaequantes, ima in bracteam filiformem spica breviorem vel multo longiorem producta. *Utriculus* erectus vel oblique patens, ovato-lanceolatus vel ellipticus, basin versus gradatim angustatus (haud rotundatus), sursum longiuscule acuminatus, acutiuscule triqueter, faciebus paullum concavus, glaber laevisque,

tenuiter herbaceus, ore obliquo integro anguste hyalinus, prominule 2–4-nervis, nervis paucis inconspicuis evanescentibus saepe additis, 5–5·1 mm. longus, 1·6–1·7 mm. latus. *Stamina* 3, filamenta haud dilatata. *Stylus* nuce brevior cum stigmatibus 3 papillosus, basi dilatata glaber. *Nux* brunnea, oblongo-elliptica, apice subtruncata umbonata, triquetra, lateribus concava, utriculo aequilata, $\frac{1}{3}$ brevior. *Rhachilla* utriculo subduplo longior.

VICTORIA.—Mount Buffalo, in rock crevices, ca. 5,000 feet, Jan. 26th, 1935, *Blake* 7398 (Type in Bri.).

I am indebted to Mr. E. Nelmes, of the Royal Botanic Gardens, Kew, for verifying the distinctness of this species.

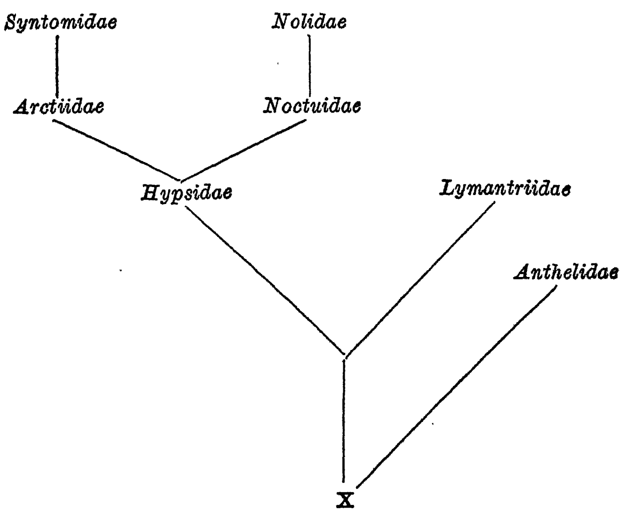
A REVISION OF THE AUSTRALIAN ARCTIIDAE (LEPIDOPTERA).*

By A. JEFFERIS TURNER, M.D., F.R.E.S.

Our first real knowledge of the Australian *Arctiidae* we owe to a paper by Meyrick in Proc. Lin. Soc. N.S.W. 1886, p. 690. He then included some genera that are now referred to the Nolidaee and Noctuidae. After substracting these, his very useful paper contains 80 species referred to 30 genera. Hampson's most valuable revision of the Arctiidae of the World Fauna followed in Cat. Lep. Phal. ii. (1900 and 1901) with a Supplement (i. 1914 and ii. 1920).

The family may be defined thus—Maxillary palpi obsolete. Labial palpi short. Antennae in male ciliated (often with longer bristles) or pectinate, very rarely simple. Forewings with 1c absent, 5 from below middle of cell, an areole present in the more primitive genera, but usually absent through coalescence. Hindwings with 1c absent, 5 usually from below middle of cell, 12 completely fused with upper margin of cell, usually to about middle. Frenulum present. Retinaculum in male almost always bar-shaped.

The *Arctiidae* are part of the superfamily *Noctuoidea* together with the *Syntomidae, Nolidae, Noctuidae, Lymantriidae, Hypsidae,* and *Anthelidae.* The relationship of these families may be represented by the following diagram:—



The most important structural character in the family is the fusion of the costal and subcostal veins of the hindwings, usually as far as the middle of the cell, sometimes nearly to its end, or even including the base of vein 7, rarely for a short distance only. This character is shared by the *Nolidae,* which differ in the presence of tufts of scales on the forewings, longêr palpi, and an expansion of the basal antennal joint by loose spreading hairs. In some genera of *Noctuidae,* including the subfamily *Sarrothripinae,* the costal vein of the hindwings anastomoses

* Except where otherwise stated, the types of all new species described in this

with the subcostal from near its base to middle of cell, but is not fused with it basally. The *Nolidae* I regard with Hampson as derived from the *Sarrothripinae,* their resemblance in neuration to the *Arctiidae* being due to convergence, and their relationship collateral. As Meyrick has pointed out, the *Arctiidae* are derived from the *Hypsidae,* some genera of which approach them closely.

In addition to the characters given in the definition, the following are noteworthy. In both wings vein 2 arises usually from near the middle of the cell, though in many genera it has moved distally. Veins 7 and 8 of the forewings are nearly always stalked. Vein 11 of forewing may either be free or may anastomose with 12. Frequently there is a reduction in the number of veins in either or both wings by coincidence, never by obsolescence; though in *Chionaema* vein 5 of hindwings is weak. The family consists of two subfamilies—*Lithosiinae* and *Arctiinae*—the first with thorax and abdomen slender and usually smooth, and the hindwings comparatively broad; in the latter thorax and abdomen are stout and usually hairy, and the hindwings comparatively short. These distinctions may not appear of much structural importance, but they indicate two very natural groups, which have followed different lines of development. From the *Arctiinae* were derived the *Syntomidae* in the Neotropical region, which is still their headquarters. The *Lithosiinae* show a strong tendency to asthenogenesis, both in reduction in size (frequently comparable to that of microlepidoptera) and in number of veins, but these two developments are not always combined.

Without being one of the largest, the *Arctiidae* are a group of considerable size. In Australia the *Lithosiinae* are well represented by over 200 species—i.e., 10 per cent. of the world fauna; but the *Arctiinae* are comparatively few, 23 species—i.e., 1 per cent. of the world fauna. Of the total 77 genera 39 are strictly endemic and 11 are Papuan. As Queensland and New Guinea formed a continuous land area in recent geological times, we may claim 50 genera, or 65 per cent., a very high degree of endemicity. The family is represented in Tasmania by 29 species and 20 genera, of which 3 are endemic to the island, but nearly related to continental genera. In West Australia there are 20 species and 13 genera, of which 2 are endemic. *Cremnophora* is the only genus which can be regarded as of western origin. No Australian *Arctiidae* appear to be of Antarctic origin.

The *Lithosiinae* comprise a number of small genera, many of them monotypical, and a few of moderate size. Their classification depends mainly on neuration. The first 25 genera form a natural group, which may be arranged in series from the more primitive *Utetheisa* and *Palaeosia* to *Lepista.* Among the remainder several groups may be distinguished, but owing to parallelism and convergence they appear somewhat indefinite, and there is an appreciable number of apparently isolated genera. The construction of a key to the genera, which must necessarily be partly artificial, has been a difficult task. Our few *Arctiinae* on the contrary are easily dealt with. There are six genera, which have lost both tongue and areole, and are nearly allied, leaving the two more primitive and isolated genera *Rhodogastria* and *Cremnophora.*

Subfam. LITHOSIINAE.

Key to Genera.

1.	Forewings with 5 absent	2		
	Forewings with 5 present	30		
2.	Hindwings with 5 absent	3		
	Hindwings with 5 present	26		
3.	Forewings without areole	4		
	Forewings with areole	29		
4.	Forewings with 4 absent	5		
	Forewings with 4 present	8		
5.	Forewings with 11 anastomosing with 12.. ..	6		
	Forewings with 11 free	7		
6.	Hindwings with 3 and 4 coincident	..	*Lepista*	1
	Hindwings with 3 and 4 stalked	..	*Chrysoscota*	3
7.	Forewings with 9 absent	..	*Meceura*	2
	Forewings with 9 present	..	*Teratopora* ♂	4
8.	Hindwings with discocellulars and 6 absent ..	..	*Hestiarcha*	5
	Hindwings with discocellulars and 6 present ..	9		
9.	Hindwings with 2 and 3 stalked	..	*Lambula*	6
	Hindwings with 2 and 3 separate	10		
10.	Forewings with 6 long-stalked with 7 and 8, 6 separating after 8	..	*Oreopola*	7
	Forewings with 6 separate or separating before 8	11		
11.	Forewings with 9 stalked with 7 and 8, or absent	12		
	Forewings with 9 and 10 stalked	..	*Melastrota*	54
12.	Forewings with 7 separating from 8 beyond 9 ..	13		
	Forewings with 7 separating from 8 before 9, or 9 absent	18		
13.	Forewings with basal ⅔ of cell constricted ..	..	*Graphosia*	8
	Forewings with cell normal	14		
14.	Palpi very short (½ or less)	15		
	Palpi moderately long (1)	16		
15.	Forewings with 6 connate or stalked, hindwings of male with costal expansion	..	*Scoliacma*	10
	Forewings with 6 separate from beneath angle, hindwings of male without costal expansion	..	*Threnosia*	11
16.	Forewings with 6 connate or stalked	17		
	Forewings with 6 separate from beneath angle ..	..	*Teratopora* ♀	4
17.	Forewings with 2 from angle	..	*Phaeophlebosia*	12
	Forewings with 2 from about middle of cell ..	..	*Tigrioides*	13
18.	Forewings with 11 anastomosing with 12 ..	19		
	Forewings with 11 free	23		
19.	Hindwings with 3 and 4 coincident	20		
	Hindwings with 3 and 4 stalked	21		
20.	Palpi obsolete, tongue weak	..	*Ateucheta*	14
	Palpi developed, tongue normal	..	*Poliosia*	15
21.	Forewings with 11 from near end of cell, tongue weak	..	*Phenacomorpha*	16
	Forewings with 11 from ⅔ or ¾, tongue normal ..	22		
22.	Forewings with 9 absent	..	*Thermeola*	9
	Forewings with 9 present	..	*Eilema*	18
23.	Forewings with 6, 7, 8, 10 stalked	..	*Ctenosia*	17
	Forewings with 6 separate	24		
24.	Forewings with 9 absent	25		
	Forewings with 9 present	..	*Aedoea*	19
25.	Forewings with 3 and 4 stalked	..	*Heterotropa*	65
	Forewings with 3 and 4 separate	..	*Atelophleps*	29
26.	Forewings with 7, 8, 9 stalked	27		
	Forewings with 9 separate	..	*Heterallactis*	68
27.	Forewings with 7 separating beyond 9	..	*Stenoscaptia*	26
	Forewings with 7 separating before 9, or 9 absent	28		
28.	Hindwings with 6 and 7 coincident	..	*Arrhythmica*	27
	Hindwings with 6 and 7 stalked	..	*Goniosema*	28

29.	Forewings with 11 anastomosing with 12	*Manulea* 21
	Forewings with 11 free	*Calamidia* 22
30.	Forewings with 5 present, hindwings with 5 absent	31
	Both wings with 5 present	33
31.	Forewings without areole	32
	Forewings with areole	*Hesychopa* 23
32.	Forewings with 9 and 10 stalked	*Parelictis* 58
	Forewings with 9 separate	*Hemonia* 69
33.	Forewings without areole	34
	Forewings with areole	69
34.	Forewings with 8 and 9 absent	*Poliodule* 31
	Forewings with 8 present	35
35.	Forewings with 7, 8, 9 stalked or 9 absent ..	36
	Forewings with 7, 8, 9, not stalked	65
36.	Forewings with 7 from 8 beyond 9	37
	Forewings with 7 from 8 before 9, or 9 absent ..	53
37.	Forewings with 11 anastomosing with 12	*Symmetrodes* 32
	Forewings with 11 free	38
38.	Hindwings with 5 weakly developed	*Chionaema* 33
	Hindwings with 5 normal	39
39.	Forewings with 2 and 3 stalked from angle ..	*Scaphidriotis* ♂ 30
	Forewings with 2 and 3 separate	40
40.	Forewings with 10 connate or stalked with 7, 8, 9	41
	Forewings with 10 separate	42
41.	Palpi hairy, forewings with 2 from ⅔ to ¾	*Eutane* 34
	Palpi not hairy, forewings with 2 from middle	*Hectobrocha* 35
42.	Forewings with 3 and 4 stalked	43
	Forewings with 3 and 4 not stalked	44
43.	Hindwings with 12 anastomosing to ⅔ of cell	*Ameleta* 37
	Hindwings with 2 anastomosing to middle	*Heliosia* 38
44.	Forewings with 4 and 5 stalked	45
	Forewings with 4 and 5 not stalked	47
45.	Hindwings with 4 absent, 3 and 5 stalked	*Aclytophane* 39
	Hindwings with 3 and 4 stalked, 5 separate ..	46
46.	Hindwings with 2 from near angle	*Porphyrochrysa* 64
	Hindwings with 2 from middle	*Scaptesyle* 40
47.	Hindwings with 12 anastomosing with cell to ⅔ or further	47
	Hindwings with 12 anastomosing to ¼	*Trissobrocha* 36
48.	Hindwings with 3 and 4 coincident	49
	Hindwings with 3 and 4 separate or stalked ..	51
49.	Forewings with 3 from well before angle ..	*Scaphidriotis* ♀ 30
	Forewings with 3 from angle	50
50.	Hindwings with 2 from angle	*Diduga* 67
	Hindwings with 2 from well before angle	*Halone* 41
51.	Forewings with costa abruptly angled	*Psapharacis* 42
	Forewings with costa not angled	52
52.	Hindwings with 3 and 4 stalked	*Caprimima* 43
	Hindwings with 3 and 4 approximated or connate ..	*Thallarcha* 44
53.	Tongue absent	54
	Tongue present	56
54.	Forewings with 6 stalked with 7 and 8	55
	Forewings with 6 separate	*Ionthas* 47
55.	Forewings with 11 from near end of cell, free	*Xanthodule* 45
	Forewings with 11 from middle, anastomosing with 12	*Thumatha* 46
56.	Forewings with 11 anastomosing with 12 ..	57
	Forewings with 11 free	59
57.	Hindwings with 4 and 5 approximated or stalked ..	*Pallene* 50
	Hindwings with 4 and 5 separate	58
58.	Antennae bipectinate in both sexes	*Asura* 48
	Antennae not bipectinate	*Habrochroma* 49
59.	Forewings with 3 and 4 coincident	*Stenarcha* 51
	Forewings with 3 and 4 not coincident	60

60. Hindwings with 3 and 4 coincident		*Baeomorpha* 66
Hindwings with 3 and 4 not coincident	61	
61. Hindwings with 3 and 4 stalked	62	
Hindwings with 3 and 4 not stalked	63	
62. Hindwings with 12 anastomosing with cell to $\frac{1}{4}$		*Chamaita* 61
Hindwings with 12 anastomosing to middle		*Nudaria* 62
63. Forewings with 9 absent	64	
Forewings with 9 present		*Oeonistis* 20
64. Forewings with 10 from end of cell		*Pseudophanes* 52
Forewings with 10 from well before end of cell.. ..		*Panachranta* 53
65. Forewings with 8 stalked with 9 and 10		*Nesotropha* 55
Forewings with 8 not stalked with 9 and 10 ..	65	
65. Forewings with 3 or 4 veinlets from 12 towards costa		*Schistophleps* 63
Forewings without costal veinlets	66	
66. Hindwings with 12 anastomosing with cell to near its end	67	
Hindwings with 12 anastomosing to $\frac{1}{3}$ or less ..	68	
67. Antennae of male ciliated, both wings with 2 from $\frac{2}{3}$		*Philenora* 56
Antennae of male simple, both wings with 2 from middle		*Notata* 57
68. Antennae of male bipectinate, hindwings with 4 and 5 closely approximated or connate		*Castulo* 59
Antennae of male not pectinate, hindwings with 4 and 5 separate		*Termessa* 60
69. Hindwings with 4 and 5 stalked		*Palaeosia* 24
Hindwings with 4 and 5 separate		*Utetheisa* 25

1. Gen. LEPISTA.

Wlgrn. Wien. Ent. Mon. vii. p. 146. Hmps. ii. p. 104.

Tongue well developed. Palpi short, ascending; second joint rough-scaled; terminal joint pointed. Posterior tibiae with two pairs of short spurs. Forewings with 2 from $\frac{3}{4}$, 3 and 4 coincident, 5 absent, 6, 7, 8, 9 stalked, 7 separating before 9, 10 from end of cell connate or approximated to 11, 11 anastomosing or running into 12. Hindwings with 2 from near angle, 3 and 4 coincident, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell. Type *L. pandula* Bdv. from Africa. There is a second African species.

1. *Lepista pulverulenta.*

Tigrioides pulverulenta Luc.; Proc. Lin. Soc. N.S.W. 1889, p. 1069.

Lepista pulvera Hmps.; Suppl. i. p. 462. Turn.; Proc. Roy. Soc. Q. 1915, p. 16.

The male is still unknown.

Queensland: Brisbane; Stradbroke Island; Tweed Heads. New South Wales: Port Macquarie.

2. Gen. METEURA.

Hmps. ii. p. 123.

Tongue well developed. Palpi short; second joint hairy; terminal joint obtuse. Antennae of male with tufts of cilia (1) and bristles (2). Posterior tibiae with two pairs of short spurs. Forewings with cell long, 2 from near angle, 3 and 4 coincident, 5 absent, 6, 7, 8, 10 stalked, 9 absent, 11 from near middle, free. Hindwings with discocellulars obsolete, 2 from near end of cell, 3 and 4 coincident, 5 absent, 6 and 7 coincident, 12 anastomosing to about middle of cell.

Only one species is recorded.

2. Meteura cervina.

Scoliacma cervina Luc.; Proc. Lin. Soc. N.S.W. 1889, p. 1068.

♂. 22–25 mm. Forewings fuscous-brown; underside in male with a large area of blackish androconia in disc excepting basal and marginal areas. Hindwings pale grey, ochreous-tinged; underside in male with a large area of grey androconia covering costal expansion and centre of disc, leaving terminal and basal areas free.

The female is unknown.

Queensland: Noosa; Brisbane.

3. Gen. CHRYSOSCOTA.

Hnps. ii. p. 109.

Tongue well developed. Palpi moderate, ascending; second joint rough-scaled; terminal joint obtuse. Antennae of male with short cilia and longer bristles. Posterior tibiae with two pairs of short spurs. Forewings with 2 from about middle, 3 and 4 coincident, 5 absent, 6, 7, 8, 9 stalked, or 6 connate, 9 separating before 7, 10 from before end of cell, 11 from $\frac{2}{3}$ running into 12. Hindwings with 2 from middle of cell, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing with cell to middle. Type, *C. auranticeps* Hmps. from New Guinea.

A small Papuan genus.

3. Chrysoscota tanyphara n.sp.

ταννφαρος, in long cloak.

♂ ♀. 25–31 mm. Head and thorax pale brownish-fuscous. Palpi $1\frac{1}{4}$; brownish; at base ochreous-whitish. Antennae grey; ciliations in male $\frac{1}{2}$, bristles 2. Abdomen dark grey; tuft whitish. Legs grey; anterior pair fuscous. Forewings narrow, elongate, slightly dilated, costa slightly arched, apex rounded, termen obliquely rounded; pale brownish-fuscous with white markings; a very slender median line from base to middle, where it dilates into a longitudinally oblong spot with strongly sinuate posterior margin; a slight oblique mark from costa before apex preceded and followed by fuscous, as is also the median spot; cilia fuscous. Hindwings broad ($1\frac{1}{2}$), termen rounded; grey; cilia grey.

North Queensland: Kuranda in September; Ravenshoe and Lake Barrine in December and May; five specimens.

4. Gen. TERATOPORA.

Meyr.; Trans. Ent. Soc. 1889, p. 459. Hmps.; ii. p. 271 and Suppl. i., p. 454.

Tongue present. Palpi moderately long (about 1) ascending. Antennae in male with cilia and bristles. Posterior tibiae with middle spurs. Forewings in male with 2 from $\frac{2}{3}$ or beyond, sometimes connected by a bar with 1, 3 and 4 coincident, 5 absent, 6 from below upper angle, 7, 8, 9, 10 stalked, 9 separating before 7, 11 anastomosing with 12; in the female 2 from towards angle, not connected with 1, 3 and 4 stalked, 10 from near end of cell. Hindwings with 2 from middle or beyond, 3 and 4 stalked or coincident, 5 absent, 6 and 7 stalked or coincident, 12 anastomosing to middle of cell.

Type *T. haplodes* Meyr. from New Guinea. A small Papuan genus. The neuration shows sexual and specific differences, and in the male an anomalous connection of 1 and 2 of the forewings in some species. Unfortunately I have not been able to examine the only Queensland species.

4. Teratopora irregularis.

Teratopora irregularis Hmps.; ii., p. 271.

Unknown to me. Hampson gives Queensland and Victoria as localities, but I doubt the correctness of the latter.

5. Gen. HESTIARCHA.

Meyr.; Proc. Lin. Soc. N.S.W. 1886, p. 736. Hmps.; Cat. Lep. Phal. ii., p. 95.

Tongue rudimentary. Palpi minute. Antennae of male bipectinate. Forewings with 2 from $\frac{3}{4}$, 3 and 4 stalked, 5 absent, 6, 7, 8 stalked, 6 separating before 8, 9 absent, 10 from cell, 11 anastomosing with 12. Hindwings with 2 and 3 stalked, 5 absent, 6 and 7 coincident, discocellulars obsolete. Monotypical.

5. Hestiarcha pyrrhopa.

Meyr.; ibid. p. 736.

Unknown to me.

South Australia: Port Lincoln.

5. Gen. LAMBULA.

Wlk.; ibid., xxxv., p. 1890. Hmps.; ibid., ii., p. 97.

Tongue well developed. Palpi short, slightly or not reaching beyond frons, slender, porrect. Antennae of male shortly ciliated with longer bristles. Thorax and abdomen slender; thorax smooth; abdomen smooth or slightly hairy on dorsum. Legs smooth; tibial spurs short, posterior tibiae with middle spurs. Forewings without areole; 2 from angle, 3 and 4 stalked, 5 absent, 6 from well below upper angle, 7, 8, 9, stalked, 9 separating before 7, 10 from upper angle, 11 from $\frac{3}{4}$ running into 12. Hindwings with 2 and 3 stalked, 4 and 5 absent, 6 and 7 stalked, 12 anastomosing with cell to beyond middle. The neuration here given is that of the female, in the male it may be distorted in connection with androconial developments, and these will be given separately with each species.

Type *L. melaleuca* Wlk. from Sula Island, near Celebes. A small genus with several Papuan species and one from Borneo.

Because of the sexual differences usually present in the species of this genus, we give a separate key for each sex.

MALES.

1. Forewings with a costal fold beneath	2	
Forewings without a costal fold		*transcripta*
2. Hindwings with a ridge of dark scales on costa beneath	3	
Hindwings without costal ridge		*pleuroptycha*
3. Forewings with veins 1 and 2 connected by a bar..		*pristina*
Forewings with 1 and 2 not connected		*phyllodes*

FEMALES.

1. Forewings with antemedian obliquely transverse line		*transcripta*
Forewings without antemedian line	2	
2. Forewings with one or two postmedian lines ..	3	
Forewings without postmedian line		*pleuroptycha*
3. Forewing lines outwardly curved		*phyllodes*
Forewing lines nearly straight		*pristina*

6. *Lambula phyllodes.*

♂ ♀. *Palaexera phyllodes* Meyr.; l.c. p. 699.

♂. *Lambula phyllodes* Hmps.; ii., p. 99.

♂. *Lambula obliquilinea* Hmps.; ii., p. 558. Pl. 35. f. 1.

Forewings in male with a costal fold beneath. Hindwings with 6 and 7 coincident and with a costal expansion with a marginal ridge of dense dark hairs.

Queensland: Nambour; Brisbane; Mount Tambourine; Macpherson Range (3,500 feet). New South Wales: Allyn River; Sydney; Bulli.

7. *Lambula pristina.*

♀. *Lithosia pristina* Wlk.; xxxv., p. 1885.

♂. *Scoliacma iridescens* Luc.; Proc. Lin. Soc. N.S.W. 1889, p. 1068.

♂. *Lambula thermopepla* Hmps.; Suppl. i., p. 445.

♂. *Lambula castanea* Roths.; Nov. Zool. xix., p. 214. Hmps.; Suppl. 1., p. 444. Pl. 25, p. 13.

Forewings in male with a costal fold beneath. Hindwings with 6 and 7 coincident and with a costal expansion suffused with dark androconia and with a ridge of dark marginal scales.

North Australia: Brock's Creek; Melville Island. Queensland: Kuranda; Nambour; Brisbane; Macpherson Range (2,500–3,500 feet). Tweed Heads. Also from New Guinea.

8. *Lambula pleuroptycha* n.sp.

πλευροπτυχος, with costal fold.

♂. 20–22 mm. Head and thorax ochreous-brown. Palpi less than 1; brown. Antennae fuscous; in male with short ciliations (½) and longer bristles (1). Abdomen pale grey; tuft ochreous. Legs brownish. Forewings elongate, costa gently arched, apex rounded, termen obliquely rounded, ochreous-brown; a costal fold beneath; fuscous androconia above forming a costal streak; paler androconia in central part of disc beneath; cilia pale grey. Hindwings with a strong costal expansion, termen rounded; pale ochreous with a brownish-ochreous central streak from base to beyond middle.

♀. 25 mm. Forewings uniform pale ochreous. Hindwings with 6 and 7 stalked; pale grey.

Queensland: Kuranda in April, May, and June. Tweed Heads in November; six specimens.

9. *Lambula transcripta.*

Tigriodes transcripta Luc.; Proc. Lin. Soc. 1890, p. 1069.
Hindwings in male with 6 and 7 coincident.

Queensland: Cairns; Atherton; Nambour; Brisbane; Toowoomba; Macpherson Range (3,000 feet). Tweed Heads.

7. Gen. OREOPOLA nov.

ὀρεοπολος, living in mountains.

Tongue present. Palpi minute, not reaching frons, slender, porrect. Thorax and abdomen slender; thorax smooth; abdomen slightly hairy on dorsum. Legs smooth; spurs moderate; posterior tibiae with middle spurs. Forewings with 2 from shortly before angle, 3 and 4 long-stalked, 5 absent, 6 long-stalked with 7 and 8, 8 separating before 6, 9 absent, 11 running into 12. Hindwings with 2 from $\frac{4}{5}$, 3 and 4 long-stalked, separating near termen, 5 absent, 6 and 7 coincident, 12 anastomosing with cell to $\frac{2}{3}$. Female unknown.

10. Oreopola athola n.sp.

ἄθολος, unstained.

♂. 26 mm. Head, palpi, thorax, and abdomen ochreous-grey. Antennae grey; ciliations in male $\frac{2}{3}$. Legs whitish-ochreous; anterior pair grey. Forewings elongate-triangular, costa slightly arched, apex rounded, termen rounded, slightly oblique; uniform ochreous-grey-whitish without markings; cilia concolorous. Hindwings broad, termen strongly rounded; colour as forewings.

Tasmania: Mount Wellington (2,500 feet) in February; one specimen.

8. Gen. GRAPHOSIA.

Hmps. ibid. ii. p. 97.

Tongue well developed. Palpi short, not reaching beyond frons, slender, porrect. Antennae of male with fascicles of cilia and longer bristles. Thorax and abdomen slender, thorax smooth; abdomen smooth (in *stenopepla*). Legs smoots; tibial spurs moderate; posterior tibiae with middle spurs. Forewings without areole; basal $\frac{2}{3}$ of cell much constricted; 2 from near angle, 3 and 4 long-stalked, 5 absent, 6, 7, 8, 9 stalked, 9 separating before 7, 10 from near upper angle, 11 anastomosing with 12. Hindwings with 2 from near angle, 3 and 4 coincident, 5 absent, 6 and 7 long-stalked, 12 anastomosing with cell to $\frac{2}{3}$. Type *G. bilineata* Hmps. from New Guinea.

This is a Papuan genus, Hampson records nine species from that region.

11. Graphosia stenopepla.

Hmps. ibid. Suppl. i. p. 444. Pl. 25, f. 12. Turn. Proc. Roy. Soc. Q. 1915, p. 15.

The male has the forewings more brownish; a fuscous streak containing a tuft of raised scales on basal part of costa; a strong costal fold on underside from base to $\frac{2}{3}$; covering a subcostal streak of raised ochreous androconial scales. Hindwings with costa strongly arched; the expanded portion covered with ochreous-fuscous scales. Abdomen with strong lateral tufts on fifth and seventh segments.

Queensland: Atherton Plateau (Ravenshoe and Millaa-Millaa, 3,000 feet); Montville (1,500 feet) near Nambour; Mount Tambourine; Macpherson Range (3,500 feet).

9. Gen. THERMEOLA.

Hmps. ii. p. 96.

Tongue present. Palpi very short, not reaching frons; slender, porrect. Antennae of male shortly ciliated. Thorax and abdomen slender; thorax smooth; abdomen slightly hairy above. Legs smooth; tibial spurs short; posterior tibiae with middle spurs. Forewings without areole, 2 from shortly before angle, 3 and 4 long-stalked, 5 absent, 6 connate or short-stalked, 7 and 8 stalked, 9 absent, 10 from before upper angle, 11 from ⅔, running into 12. Hindwings much broader than forewings (1½); cell short (⅓), 2 from near angle, 3 and 4 long-stalked, 5 absent, 6 and 7 coincident, 12 anastomosing with cell to ⅖. Female with very small aborted wings. Monotypical.

12. *Thermeola tasmanica.*

Thermeola tasmanica Hmps. ii. p. 96.

Hestiarcha atala Turn. Proc. Roy. Soc. Vic. 1922, p. 29.

♂. 28-30 mm. Head and thorax pale brown. Antennae pale brown; ciliations in male ⅔. Abdomen ochreous-grey; tuft ochreous-brown. Legs anteriorly fuscous; posteriorly pale ochreous; posterior tibiae and tarsi wholly pale ochreous. Forewings elongate-triangular costa gently arched, apex rounded, termen rounded, slightly oblique; pale yellowish-brown with some pale fuscous irroration; an obscure dentate, interrupted, narrow, fuscous fascia from ⅔ costa to ⅗ dorsum; cilia concolorous. Hindwing much broader than forewings, strongly rounded; pale ochreous; cilia pale ochreous.

Tasmania: Mount Wellington (1,500-2,500 feet).

10. Gen. SCOLIACMA.

Meyr. l.c. 1886, p. 695. Hmps. ii., p. 192.

Tongue well developed. Palpi very short (½); second joint hairy; terminal joint obtuse. Antennae in male with ciliations and bristles. Posterior tibiae with two pairs of short spurs. Forewings usually with costal fold in male; 2 usually from well before but sometimes from near angle, 3 and 4 stalked, rarely separate in male, 5 absent, 6 from upper angle, connate or stalked with 7, 8, 9, which are stalked, 9 separating before 7, 10 from before angle, 11 from about ¾, anastomosing with 12. Hindwings with costal expansion in male, 2 from ¾ or near angle, 3 and 4 coincident, 5 absent, 6 and 7 stalked, rarely coincident in male, 12 anastomosing with cell to middle or beyond.

Type. *S. bicolor.* Distinguished from *Threnosia* by the strong costal expansion of hindwings in male. Occurs also in New Guinea.

KEY TO SPECIES.

1.	Both wings partly crimson-red		*bicolor*
	Wings not red	2	
2.	Forewings narrow	3	
	Forewings moderately broad	5	
3.	Forewings with dorsum strongly sinuate		*lophopyga*
	Forewings with dorsum not sinuate	4	
4.	Hindwings pale ochreous		*nana*
	Hindwings whitish-grey		*pasteophora*
5.	Forewings with oblique fuscous transverse line ..		*xuthopis*
	Forewings without transverse line	6	
6.	Forewings pale brownish sprinkled with fuscous ..		*pactolias*
	Forewings ochreous without fuscous sprinkling ..		*acosma*

13 Scoliacma bicolor.

Lithosia bicolora Bdv. Voy. Astrolabe Lep., p. 211, Pl. 3, f. 9. Hmps. ii., p. 103.

Scoliacma bicolor Meyr. l.c., p. 695.

Antennae in male with ciliations ½, bristles 1½. Forewings in male with strong costal fold to ⅘. Hindwings with strong costal expansion, a large raised oval patch of androconia in cell, 6 and 7 coincident. Examples from the Atherton Plateau are a local race with fuscous area of forewings extending nearly to base (*herbertonensis*).

Queensland: Herberton; Eungella; Killarney; Stanthorpe. New South Wales: Glen Innes; Murrurundi; Scone; Newcastle; Sydney; Uralla; Bombala. Victoria: Melbourne; Gisborne; Beaconsfield; Dunkeld; Gunbower; Moe. Tasmania: Launceston; Hobart; Tasman Peninsula.

14. Scoliacma lophopyga n.sp.

λοφοπυγος, with crested rump.

♂. 24 mm. Head and thorax pale brownish-grey. Palpi fuscous-brown. Antennae grey; in male bases of segments thickened and with tufts of cilia (1½). Abdomen in male with basal segments whitish-grey; terminal segments whitish-ochreous with four pairs of lateral tufts in addition to terminal tuft. Forewings narrow, costa gently arched, apex rounded, termen slightly rounded, slightly oblique, dorsum strongly sinuate; beneath with a strong costal fold edged with rough scales to beyond middle and an oval subcostal glandular thickening at ¼ on upper surface; pale brownish-grey sprinkled with fuscous; a fuscous costal streak from base to ½; and oblique fuscous line fron ⅘ costa to ⅔ dorsum, its outer edge dentate; cilia pale grey. Hindwings with termen rounded, in male with a strong rounded costal expansion with dark androconia beneath; ochreous-grey-whitish; a suffused grey postmedian spot; cilia ochreous-whitish.

Queensland: Ravenshoe in March; one specimen received from Mr. W. B. Barnard, who has the type.

15. Scoliacma pactolias.

Meyr. l.c., p. 696. Hmps. ii. p. 104.

♂. 28 mm. ♀. 29-34 mm. Head, palpi, and thorax fuscous-brown, paler in female. Antennae grey; ciliations in male 1, bristles 2½. Abdomen grey; tuft whitish-ochreous. Legs whitish-ochreous; anterior pair sometimes fuscous. Forewings narrow, costa straight to ⅔, thence gently arched, apex rounded termen obliquely rounded; in male with a costal fold beneath to ¾ edged with rough scales; pale brownish sprinkled with fuscous; in male a faint suffused fuscous line from ⅘ to mid-dorsum; cilia grey. Hindwings with termen gently rounded; pale grey, in female ochreous-tinged; cilia concolorous.

Queensland: Bunya Mountains in February. New South Wales: Acacia Plateau (2,500 feet) (near Killarney, Q.) in March; Mount Tomah in March. Victoria: Melbourne in April.

16. Scoliacma xuthorpis.

Hmps. Suppl. i., p. 461. Turn. Proc. Roy. Soc. Q., 1915, p. 16.

Antennae in male with ciliations 1, bristles 1½. Forewings with costal fold to middle, 2 from near end of cell, straight; hindwings with

costal expansion suffused with fuscous androconia, a vesicular thickening on costal margin of cell.

Forewings of female with 4 from $\frac{4}{5}$, curved at base; the longitudinal thickening of wing membrane running into this curve is not a vein; it is present only in the type, and has apparently no significance.
West Australia: Albany; Denmark; Margaret R.; Yanchep.

17. *Scoliacma pasteophara* n.sp.

πaστεoφopoς, in peppered cloak.

♂ ♀. 25-26 mm. Head and thorax whitish-grey. Palpi very short; whitish-grey. Antennae grey; ciliations in male 1, bristles $1\frac{1}{2}$. Abdomen pale grey; tuft grey-whitish. Legs grey-whitish; anterior pair pale grey. Forewings narrow, elongate, posteriorly dilated, costa straight to near apex, apex rounded, termen obliquely rounded; in male without costal fold; whitish sprinkled with grey; a narrow interrupted grey fascia from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, its outer edge sharply dentate; cilia grey-whitish. Hindwings with termen rounded; costal expansion in male narrow with some androconial irroration; grey-whitish; cilia grey-whitish.

West Australia: Busselton; Rottnest I.; two specimens.

18. *Scoliacma nana.*

Lithosia nana Wlk. ii., p. 507 (*nec.* Meyr. l.c., p. 698).

Scoliacma orthotoma Meyr. l.c., p. 696. *Pusiola nana* Hmps. ii., p. 119.

Antennae in male with tufts of cilia (1) and bristles ($1\frac{1}{2}$). Forewings in male pale brownish-ochreous; sometimes with a suffused interrupted grey line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum; in female pale grey with a whitish costal streak; rarely indications of an oblique darker line; in male with costal fold to $\frac{2}{3}$; a long patch of fuscous androconia on dorsal side of cell, and broader beyond cell, covered by a large costal expansion of hindwings. Hindwings in both sexes pale ochreous.

Queensland: Herberton; Gayndah; Brisbane; Rosewood; Macpherson Range, 3,500 feet; Toowoomba; Warwick; Killarney. New South Wales: Sydney.

19. *Scoliacma acosma.*

Turn. Trans. Roy. Soc. S.A., 1899, p. 10.

Forewings pale brownish-ochreous, rather paler in female; in male a costal fold to $\frac{2}{3}$. Hindwings in male rhombiform, angled on vein 2; pale ochreous; costal expansion in male suffused with pale fuscous androconia. Antennae in male with ciliations $\frac{1}{4}$, bristles 1.

The type is a male, not female as stated in the description.

Queensland: Cairns; Innisfail; Ayr; Duaringa.

11. Gen. THRENOSIA.

Hmps. ii., p. 96.

Tongue well developed. Palpi very short ($\frac{1}{2}$ or less), porrect or drooping. Antennae of male shortly ciliated with longer bristles. Thorax and abdomen slender; thorax smooth, abdomen slightly rough on dorsum. Legs smooth; tibial spurs short; posterior tibiae with middle

spurs. Forewings without areole; 2 from near angle, 3 and 4 stalked, 5 absent, 6 from below upper angle, 7, 8, 9, stalked, 9 separating before 7, 10 from near end of cell, 11 from $\frac{3}{4}$, running into or anastomosing with 12. Hindwings in male without costal expansion; 2 from near angle, 3 and 4 long-stalked or coincident, 5 absent, 6 and 7 coincident or separating near termen, 12 anastomosing with cell to middle or $\frac{2}{3}$. *T. heminephes*. Endemic.

20. *Threnosia heminephes*.

Meyr. ibid., 1886, p. 697.

New South Wales: Scone; Bathurst.

21. *Threnosia adrasta* n.sp.

ἀδραστος, sluggish.

♂. 34 mm. Head whitish-ochreous. Palpi $\frac{1}{2}$; fuscous. Antennae grey; ciliations in male $\frac{1}{2}$; bristles 2. Thorax reddish-brown. Abdomen pale ochreous-grey; lateral hairs towards apex reddish-brown. Legs reddish-brown. Forewings elongate, posteriorly dilated, costa straight to near apex, apex rounded, termen rounded, slightly oblique; reddish-brown, cilia reddish-brown. Hindwings with termen rounded; whitish-ochreous; cilia whitish-ochreous.

Tasmania: King I.; one specimen. Type in National Museum, Melbourne.

22. *Threnosia myochroa* n.sp.

μυοχροος, mouse-coloured.

♂. 29 mm. Head, palpi, and thorax brownish-grey. Antennae grey; ciliations in male $\frac{1}{2}$, bristles 2. Abdomen grey, towards apex ochreous-tinged. Legs fuscous; posterior pair pale grey. Forewings elongate-triangular, costa slightly arched, apex obtusely pointed, termen slightly rounded, oblique; brownish-grey; a faintly darker line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; cilia fuscous, apices paler. Hindwings with termen rounded; pale ochreous-grey; cilia concolorous.

Victoria: Castlemaine in April (W. E. Drake); one specimen received from Mr. Geo. Lyell, who has the type.

23. *Threnosia agraphes* n.sp.

ἀγραφης, unmarked.

♂. 20 mm. Head and thorax brown. Palpi fuscous. Antennae grey-brown; ciliations in male 1, bristles 2. Abdomen fuscous. Legs ochreous-grey. Forewings elongate-triangular, costa slightly arched, apex rounded, termen slightly rounded, oblique; pale ochreous-grey; cilia whitish-ochreous. Hindwings with termen rounded; ochreous-grey; cilia ochreous-whitish.

Smaller than *T. myochroa*, the wings paler, the antennal ciliations in male longer.

Victoria: Murtoa; one specimen received from Mr. Geo. Lyell, who has the type.

24. *Threnosia hypopolia* n.sp.

ὑποπολιος, grey.

♀. 20 mm. Head, palpi, antennae, and thorax grey. Abdomen whitish grey. Legs pale grey. Forewings narrowly triangular, costa slightly arched, apex rectangular, termen obliquely rounded; grey; cilia

grey. Hindwings with termen gently rounded; pale grey; cilia pale grey.

Fore wings narrower than in *T. agraphes,* their apices rectangular, grey without ochreous tinge.

Victoria: Gisborne in April; one specimen received from Mr. Geo. Lyell, who has the type.

12. Gen. PHAEOPHLEBOSIA.

Hmps. 11., p. 109.

Tongue present. Palpi about 1, smooth, slender, porrect. Posterior tibiae with middle spurs. Forewings narrow; 2 from near angle, 3 and 4 stalked, 5 absent, 6, 7, 8, 9 stalked, 9 separating before 7, 10 from near end of cell, 11 from towards end, free. Hindwings broad; 3 and 4 stalked, 5 absent, 6 and 7 coincident, 12 anastomosing with cell to $\frac{4}{5}$. Montypical.

25. *Phaeophlebosia furcifera.*

Setina furcifera Wlk. ii., p. 520.

Setina trifurcata Wlk. xxxi., p. 237.

Tigrioides furcifera Meyr. l.c., p. 698.

Phaeophlebosia furcifera Hmps. ii., p. 109.

New South Wales: Ebor. Victoria: Melbourne: Healesville; Gisborne. Tasmania: Hobart; Bothwell; Waratah.

13. Gen. TIGRIOIDES.

Butl. Trans. Ent. Soc. 1887, p. 359. Hmps., Suppl. i., p. 466.

Tongue well developed. Palpi moderate (1), porrect; second joint rough-scaled; terminal joint obtusely pointed. Antennae in male with ciliations and bristles. Posterior tibiae with middle spurs. Forewings with 2 from about middle, 3 and 4 stalked, 5 absent, 6 from upper angle connate with 7, 8, 9, which are stalked, 9 separating before 7, 10 from before end of cell, 11 from middle, anastomosing with 12. Hindwings with 2 from $\frac{3}{4}$, 3 and 4 staked, 5 absent, 6 and 7 stalked, 12 anastomosing to beyond middle of cell. Type *T. alterna.* A small genus represented also in the Archipelago and India with one species in Africa.

26. *Tigrioides alterna.*

Setina alterna Wlk. ii., p. 520.

Tigrioides alterna Meyr. l.c., p. 697.

Lithosia histrionica H-Sch. Ausser. Schmet. f. 440.

Lithosia transversa Wlk. xxxi., p. 229.

Lexis alterna Hmps. ii., p. 117.

Queensland: Mount Tambourine; Macpherson Range, 2,000 feet; Toowoomba; Killarney. New South Wales: Lismore; Murrurundi, Sydney; Katoomba; Bathurst. Victoria: Melbourne: Gisborne. South Australia: ———.

27. *Tigrioides nitens.*

Lithosia nitens Wlk., xxxi., p. 231.

Lithosia remota Wlk. Char. Undesc. Lep., p. 9.

Tigrioides spilarcha Meyr. l.c., p. 699.

Lithosia unicolor Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1071.

Lexis nitens Hmps. ii., p. 118.

Queensland: Herberton; Kuranda; Townsville; Lindeman I.; Yeppoon; Eidsvold; Gayndah; Gympie; Kingaroy; Noosa; Caloundra; Brisbane; Stradbroke I.; Tweed Heads; Macpherson Range, 3,500 feet; Helidon; Toowoomba; Bunya Mountains, 3,500 feet. New South Wales: Tabulam; Ebor; Sydney. Victoria: Melbourne; Kewell; Berwick.

14. Gen. ATEUCHETA nov.

ἀτευχητος, unarmed.

Tongue weak. Palpi extremely minute. Posterior tibiae with two pairs of spurs. Forewings with 2 from $\frac{2}{3}$, 3 and 4 connate or stalked, 5 absent, 6 from below upper angle, 7, 8, 9 stalked, 7 separating before 9, or 9 absent, 10 from before end of cell, 11 from $\frac{2}{3}$ running into 12. Hindwings with 2 from angle, 3 and 4 coincident, 5 absent, 6 and 7 stalked, 12 anastomosing with cell to middle.

Differs from *Poliosia* in the weak tongue and obsolete palpi.

28. *Ateucheta zetesima.*

Poliosia zatesima (misprint) Hmps. Suppl. i., p. 463.

Poliosia zetesima Turn. Proc. Roy Soc. Q., 1915, p. 16.

Antennae in male with cilia $\frac{1}{2}$.

North Queensland: Cairns; Atherton Plateau.

15. Gen. POLIOSIA.

Hmps. ii., p. 106.

Tongue well developed. Palpi short. Posterior tibiae with two pairs of spurs. Forewings with 2 from before angle, 3 and 4 stalked, 5 absent, 7, 8, 9 stalked, 7 separating before 9, 10 free, 11 anastomosing with 12. Hindwings with 2 from before angle, 3 and 4 coincident, 5 absent, 6 and 7 stalked, 12 anastomosing with cell to middle. Type, *P. muricolor* Wlk., from Borneo and India. There are several Indian and two African species.

29. *Poliosia fragilis.*

Brunia fragilis Luc. Proc. Roy. Soc. Q., 1889, p. 1070. *Poliosia fragilis* Hmps. ii., p. 109, Pl. 21, f. 1.

I do not know this species.

Queensland: Brisbane.

16. Gen. PHENACOMORPHA nov.

φενακομορφος, misleading.

Tongue weakly developed. Palpi very short, hairy. Antennae in male bipectinate to apex. Abdomen slightly hairy on dorsum. Posterior

tibiae with middle spurs; spurs short. Forewings with 2 from near angle, 3 and 4 long-stalked, 5 absent, 6, 7, 8 stalked, 9 absent, 10 from upper angle, 11 from near end of cell, anastomosing with 12. Hindwings broader than forewings; cell ½; 2 from near angle, 3 and 4 long-stalked, 5 absent, 6 and 7 coincident, 12 anastomosing to beyond middle of cell.

In spite of similarities in structure I do not consider that this genus is nearly related to *Thermeola*.

30. *Phenacomorpha rhabdophora.*

Thallarcha rhabdophora Turn. Trans. Roy. Soc. S.A., 1899, p. 19.

Thermeola rhabdophora Hmps. ii. p. 558.

Queensland: Toowoomba in August; Stanthorpe in October and December; Talwood in April: New South Wales: ——.

17. Gen. CTENOSIA.

Hmps. ii., p. 130.

Tongue well developed. Palpi short. Posterior tibiae with middle spurs. Forewings with 2 from near angle, 3 and 4 stalked, 5 absent, 6, 7, 8, 10 stalked, 8 separating after 6, 9 absent, 7 separating before 10, 11 free. Hindwings with 2 from end of cell, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell. Type *C. trifascia* B-Bak. from New Guinea. There is also one species from Batchian and one from Africa.

31. *Ctenosia infuscata.*

Ctenosia infuscata Low. Proc. Lin. Soc. N.S.W., 1901, p. 640. Hmps., Suppl. i., p. 482.

I do not know this species and have some doubt as to its generic position.

New South Wales: Broken Hill.

18. Gen. EILEMA.

Eilema Hb. Verz., p. 165. *Ilema* Hmps., p. 130.

Tongue well developed. Palpi short, porrect; second joint rough-scaled; terminal joint obtuse. Antennae of male with ciliations and bristles. Posterior tibiae with two pairs of short spurs. Forewings without areole; 2 from middle, 3 and 4 stalked, 5 absent, 6 from upper angle or below, 7, 8, 9 stalked, 7 from before 9, 10 from before end of cell, 11 from ⅔, anastomosing with 12. Hindwings with 2 from ⅔, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to beyond middle of cell. Type, *E. caniola* Hb. from Europe. A large genus widely distributed in the eastern hemisphere.

32. *Eilema chiloides.*

♀. *Teulisna chiloides* Wlk. Lin. Soc. Zool., vi., p. 19. Hmps. ii., p. 135.

♂. *Coreura torta* Wlk. l.c., p. 111.

Ityca humeralis Wlk. xxxv., p. 1890.

Diastrophia dasypyga Feld. Reis. Nov. Pl. 106, f. 13.

I do not know this species. It is widely spread in the Malay Archipelago and Hampson records it from Queensland.

33. Eilema bipunctata.

Lithosia bipunctata Wlk. xxxv., p. 1884. Hmps. ii., p. 136.

Corcura mysolica Swin. Cat. Oxf. Mus., i., p. 119, Pl. 3, f. 18.

Antennae of male with ciliations ½, bristles 1. Forewings elongeta-triangular, costa sinuate, termen straight, slightly oblique; in male with dense ridge of scales on costa above from base to ⅓; ochreous-whitish, suffused with pale ochreous-brown in dorsal area to ⅘ and on termen; in male an oblique subquadrate blackish mark on costa before middle; cilia greyish-ochreous, in female pale grey. Hindwings with termen slightly rounded; pale ochreous; cilia pale ochreous.

North Queensland: Kuranda in September, February, and April; Lake Barrine in June.

34. Eilema harpophora.

♀. *Brunia harpophora* Meyr. l.c., p. 701.

Ilema harpophora Hmps. ii., p. 167, Pl. 22, f. 27.

♂. *Brunia repleta* Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1070.

Ilema repleta Hmps. ii., p. 143, Pl. 21, f. 28.

♀. *Tigrioides xanthopleura* Turn. Trans. Roy. Soc. S.A., 1899, p. 10.

Ilema costistrigata B-Bak. Nov. Zool. xi., p. 419, Pl. 5, f. 30.

Queensland: Cooktown; Cairns; Brisbane; Toowoomba. New South Wales: Lismore; Port Macquarie; Mount Wilson. Also from New Guinea.

19. Gen. AEDOEA.

Turn. Trans. Roy. Soc. S.A., 1899, p. 10.

Tongue present. Palpi very small, Antennae in male with ciliations and bristles. Posterior tibiae with middle spurs. Forewings with 2 from ⅗, 3 and 4 stalked, 5 absent, 6 from upper angle, 7, 8, 9 stalked, 7 separating before 9, 10 from before end of cell, 11 from ⅗, free. Hindwings with 2 from ¾, 3 and 4 long-stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *A. decreta* Butl.

Only two species known.

35. Aedoea decreta.

Lithosia decreta Butl. Trans. Ent Soc., 1877, p. 351.

Aedoea monochroa Turn. Trans. Roy. Soc. S.A., 1899, p. 10.

Ilema decreta Hmps. ii., p. 176, Pl. 23, f. 7.

Queensland: Brisbane. Also from Borneo.

36. Aedoea distigmata n.sp.

διστιγματος, with two dots.

♂. 18 mm. Head whitish. Palpi 1¼, whitish. Antennae ochreous-whitish; in male shortly laminate, cilia ¼, bristles ½. Thorax ochreous-whitish. Abdomen grey-whitish. Legs ochreous-whitish. Forewings

suboval, costa gently arched, apex round-pointed, termen gently rounded, oblique; ochreous-whitish; fuscous discal dots at $\frac{1}{3}$ and $\frac{2}{3}$; cilia ochreous-whitish. Hindwings with termen gently rounded; ochreous-whitish; cilia ochreous-whitish.

North Queensland: Tully in July; one specimen.

20. Gen. OEONISTIS.

Hb. Verz., p. 165. Hmps. ii., p. 185.

Tongue well developed. Palpi short, ascending; second joint rough-scaled; terminal joint obtuse. Antennae in male bipectinate, apical third simple. Posterior tibiae with two pairs of short spurs. Forewings with 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 connate, 6 from near upper angle, 7, 8, 9 stalked, 7 separating before 9, 10 from well before end of cell, 11 from $\frac{3}{4}$, free. Hindwings with 2 from middle, 3 closely approximated to or connate with 4 and 5, which are stalked from angle, 6 and 7 connate or short-stalked, 12 anastomosing to middle of cell. Type, *O. entella*. There are also two species from New Guinea and one from Lifu.

37. Oeonistis entella.

Tinea entella Cram. Pap Exot. iii., Pl. 208D.

Noctua convoluta Fab. Spec. Ins. ii., p. 215.

Noctua delia Fab. Mant. Ins. ii., p. 140.

Tigrioides splendens Luc. Proc. Lin. Soc. N.S.W., 1890, p. 1068.

Specimens from Australia are sometimes referred to the subspecies *delia*, which shows slight differences from the typical form, which occurs in China, Ceylon, and India.

North Australia: Amsterdam I. Queensland: Cairns; Innisfail; Atherton Plateau; Bowen; Mackay. Also from the Archipelago.

21. Gen. MANULCA.

Wlgrn. Wien. Ent. Mon. vii., p. 145.

Tongue well developed. Palpi short, porrect; second joint rough-scaled; terminal joint obtuse. Antennae of male with ciliations and bristles. Posterior tibiae with two pairs of short spurs. Forewings with a well-developed areole, rhomboidal in shape with an acute apex; 2 from middle, 3 and 4 stalked, 5 absent, 7 connate with 8, 9, which are stalked from apex of areole, 10 from middle of areole, 11 from $\frac{2}{3}$, anastomosing with 12. Hindwings with 2 from middle, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to beyond middle. Type, *M. gracilipennis* Wlgrn. from Africa.

Distinguished from *Eilema* by the well-developed areole and from *Hesychopa* by the absence of 5 in forewings. A small genus but like *Eilema* widely distributed.

38. Manulca dorsalis.

Lithosia dorsalis Wlk. xxxv., p. 1883.

Ilema dorsalis Hmps. ii., p. 159, Pl. 22, f. 10.

♂. 30-38 mm. Head ochreous-yellow; face dark fuscous. Palpi 1; ochreous-yellow; upper surface fuscous towards apex. Antennae

fuscous; ciliations in male ½, bristles 1. Thorax fuscous; anterior margin and sometimes a posterior spot ochreous-yellow. Abdomen ochreous. Legs fuscous, anterior coxae ochreous. Forewings elongate, costa straight, apex rounded, termen obliquely rounded; pale grey; a large fuscous terminal blotch, its anterior margin straight, not reaching costa; costal edge sometimes dark fuscous; cilia whitish-ochreous. Hindwings with termen gently rounded; pale ochreous; cilia pale ochreous.

♀. 30-42 mm. Forewings glossy leaden-fuscous; a broad pale ochreous costal streak continued round apex to torbus.

North Australia: Darwin; Brock's Creek. Queensland: Thursday Island; Cairns, Atherton Plateau; Bundaberg; Gympie; Brisbane. Also from New Guinea and Sula Island.

39. Manulca replana.

Phalaena replana Lew. Prodr Ent., p. 16, Pl. 15.

Brunia replana Meyr. l.c., p. 701.

Ilema replana Hmps. ii., p. 162.

Lithosia dispar Leach. Zool. Misc. i., p. 109, Pl. 49, f. 1-3.

The form with yellowish suffusion, more common but not invariably present in the male, occurs in both sexes.

Queensland: Gayndah; Nanango; Nambour; Brisbane; Rosewood; Toowoomba. New South Wales: Macleay River; Sydney; Jervis Bay.

22. Gen. CALAMIDIA.

Butl. Trans. Ent. Soc. 1877, p 358. Hmps. ii., p. 181.

Tongue well developed. Palpi ascending, moderate in female; very long in male. Antennae with minute ciliations and short bristles in both sexes. Posterior tibiae with middle spurs. Forewings with a pentagonal areole, its posterior edge short; 2 from ⅔ or before, 3 and 4 separate, 5 absent, 6 from upper angle, 7 from posterior inferior and 8, 9 stalked from posterior superior angle of areole, 10 from middle of areole, 11 from ⅔, free. Hindwing broad; 2 from middle, 3 and 4 connate, 5 absent, 6 and 7 connate or closely approximated, 12 anastomosing to middle of cell. Type, *C. hirta*. A small Papuan genus.

40. Calamidia hirta.

♀. *Lithosia hirta* Wlk. ii., p. 510.

Calamidia hirta Meyr. l.c. p. 694.

♂. *Calamidia salpinctis* Meyr. l.c., p. 694.

Palpi in male extremely long, smooth; second joint exceeding vertex; terminal joint longer than second, spathulate at apex; in female moderate, appressed to face, not reaching vertex; terminal joint short, acute.

Queensland: Cairns; Atherton Plateau; Eungella; Nambour; Brisbane; Bunya Mountains; Killarney. New South Wales: Lismore; Ebor; Sydney; Jervis Bay. Victoria: Tasmania: Burnie.

28. Gen. HESYCHOPA nov.

ἡσυχωπος, soft, gentle.

Tongue well developed. Palpi moderate (1); second joint shortly rough-scaled; terminal joint obtusely pointed. Antennae in male with ciliations and bristles. Posterior tibiae with middle spurs. Forewings with a large areole wide at base, narrower and rounded at apex; 2 from near middle, 3, 4, 5 approximated from angle, 6 from upper angle or from areole, 7 and 10 from near end of areole, 8 and 9 stalked from its apex, 11 curved and approximated to 12, rarely anastomosing. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *H. chionora* Meyr. Australian.

41. Hesychopa molybdica n.sp.

μολυβδικος, leaden.

♂. 32-37 mm. Head grey. Palpi 1; fuscous, at base whitish-ochreous. Antennae fuscous; ciliations in male $\frac{1}{2}$, bristles $1\frac{1}{2}$. Thorax lustrous leaden-grey; posterior edge pale ochreous. Abdomen grey-whitish. Legs whitish-ochreous; anterior pair fuscous. Forewings elongate, strongly dilated, costa straight to $\frac{3}{4}$, thence arched, apex rounded, termen obliquely rounded; glossy leaden-grey; a white costal streak from base to $\frac{4}{5}$; costal edge ochreous, near base blackish; cilia white. Hindwings with termen gently rounded; whitish; cilia whitish. Underside of forewings with basal half and a costal streak ochreous; of hindwings, ochreous on costal half of basal area.

♀. 36-40 mm. Head fuscous. Thorax white; patagia fuscous. Forewings uniformly white without markings. Hindwings as in male. Underside of both wings white; costal edge of both and base of forewings ochreous-tinged.

North Queensland: Atherton Plateau (Ravenshoe, Millaa Millaa, Lake Barrine, and Malanda) in June, September, November, December, and January; seven specimens.

42. Hesychopa chionora.

Lithosia chionora Meyr. l.c., p. 702.

Apistosia chionora Hmps. ii., p. 226.

Queensland: Atherton Plateau; Nambour; Brisbane; Mount Tamborine; Macpherson Range, 3,400 feet; Toowoomba; Bunya Mountains. New South Wales: Ebor; Sydney; Mount Wilson. Tasmania: Launceston.

24. Gen. PALAEOSIA.

Hmps. ii., p. 227.

Tongue well developed. Palpi short, porrect; second joint rough-scaled; terminal joint obtuse. Antennae in male with ciliations and bristles. Posterior tibiae with middle spurs. Forewings with a large areole, wide at base, apex rounded; 2 from near angle, 3, 4, 5 approximated, 6 from upper angle, 7 and 10 from near end of areole, 8 and 9 stalked from its apex, 11 from $\frac{4}{5}$, anastomosing with 12. Hindwings with 2 from middle, 3, 4, 5 stalked or 3 connate, 6 and 7 stalked, 12 anastomosing to middle of cell.

Nearly allied to *Hesychopa,* from which it differs in the presence of vein 5 in the hindwings. Monotypical.

43. *Palaeosia bicosta.*

Lithosia bicosta Wlk. ii., p. 506. Meyr. l.c., p. 702.

Palaeosia bicosta Hmps. ii., p. 227.

Lithosia fraterna Butl. Trans. Ent. Soc. 1877, p. 349.

Queensland: Macpherson Range, 3-4,000 feet. New South Wales: Glen Innes; Ebor; Sydney; Mount Wilson. Victoria: Melbourne, Gisborne; Moe. Tasmania: Launceston; Deloraine; Waratah; Rosebery; Hobart; Bothwell; Coles Bay; Wilmot. South Australia: Mount Lofty.

25. Gen. UTETHEISA.

Hb. Verz., p. 168. Hmps. iii., p. 480.

Tongue well developed. Palpi moderately long, ascending, thickened with appressed scales, rough-scaled at base beneath, obtuse. Antennae in male usually simple with cilia and bristles but sometimes serrate or shortly bipectinate. Thorax and femora smooth. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 from upper angle or beneath, 7, 8, 9 stalked, 10 from near end of cell anastomosing with 8 to form an areole, 11 from near end, free. Hindwings much broader than forewings (over 2); 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 and 7 approximated, 12 anastomosing with cell to $\frac{2}{5}$ or middle. Type, *U. bella* Lin. from North America. A small genus characteristic of the tropics of both hemispheres. It is a somewhat isolated and primitive form, which by its slender build and very broad hindwings seems to me more nearly related to *Palaeosia*, though Hampson places it in the *Arctiinae*. *Utetheisa* Hb. has priority over *Deiopeia* Curt. A genus of moderate size characteristic of the Old and New World tropics.

KEY TO SPECIES.

1. Hindwing of male with a subdorsal fold and tuft of hair on upper side	2	
Hindwings of male without fold and tuft		*pulchella*
2. Antennae of male shortly bipectinate		*pectinata*
Antennae of male serrate		*pulchelloides*

44. *Utetheisa pectinata.*

Utetheisa pectinata Hmps. Ann. Mag. Nat. Hist. (7), xix., p. 240, and Suppl. ii., p. 509, Pl. 68, f. 17.

North Australia: Port Essington.

45. *Utetheisa pulchelloides.*

Utetheisa puchelloides Hmps. Ann. Mag. Nat. Hist. (7), xix., p. 239, and Supl. ii., p. 510, Pl. 68, f. 18.

North Australia: Darwin; Baudin Island. North Queensland: Cape York; Cooktown. North-West Australia: Montebello Island. Also from New Guinea, Solomons, and Polynesian Islands.

46. *Utetheisa pulchella.*

Tinea pulchella Lin. Syst. Nat., i., p. 534.

Noctua pulchra Den. & Schif. Wien. Verz., p. 68.

Geometra lotrix Cram. Pap. Exot., ii., Pl. 109, f. E.F.

Deiopeia thyter Butl. Tr. Ent. Soc. 1877, p. 361.

Deiopeia pulchella Meyr. l.c., p. 758.

Utetheisa pulchella Hmps. iii., p. 483.

North Australia: Darwin; Brock's Creek; Newcastle Waters; Macdonnell Ranges. Queensland: Thursday Island; Cairns; Innisfail; Atherton Plateau; Dunk Island; Palm Island; Townsville; Charters Towers; Bowen; Mackay; Lindeman I.; Yeppoon; Eidsvold; Gayndah; Gympie; Brisbane; Toowoomba; Dalby; Roma; Charleville; Adavale; Winton. New South Wales: Glen Innes; Ebor; Murrurundi; Newcastle; Sydney; Jervis Bay; Broken Hill. Victoria: ———. Tasmania: Launceston; Strahan. South Australia: Mount Lofty. West Australia: Perth. North-West Australia: Wyndham. Also from China, India, Africa, and Europe.

26. Gen. STENOSCAPTIA.

Hmps. ii., p. 280.

Tongue well developed. Palpi short, ascending, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{5}{6}$, 3 and 4 separate or stalked, 5 absent, 6 from below upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from before end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 coincident, 5 separate from above angle, 6 and 7 coincident, 12 anastomosing to middle of cell. Type, *S. venusta*. Endemic.

In male with a tuft of long hairs beneath on vein 5 beyond middle. Forewings with 3 and 4 stalked.

47. Stenoscaptia phlogozona.

Stenoscaptia phlogozona Turn. Trans. Roy Soc. S.A., 1904, p. 212. Hmps. Suppl. i., p. 589.

North Queensland: Cairns; Townsville. Also from New Guinea.

48. Stenoscaptia venusta.

Stenoscaptia venusta Luc. Proc. Lin. Soc. N.S.W., 1890, p. 1078. Hmps. Suppl. ii., p. 28.

Forewings with 3 and 4 separate.

Queensland: Brisbane; Milmerran.

27. Gen. ARRHYTHMICA nov.

ἀρρύθμικος, disorderly.

Tongue present. Palpi short, ascending, smooth, slender, acute. Antennae of male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from towards angle, 3 and 4 long-stalked, 5 absent, 6 from upper angle, 7, 8, 10 stalked, 9 absent, 11 from near end of cell, free. Hindwings with cell $\frac{1}{2}$; 2 from $\frac{2}{3}$, 3 and 4 long-stalked, 5 nearly approximated, 6 and 7 coincident, 12 anastomosing to middle of cell.

Allied to *Goniosema,* with which it agrees in neuration of forewings.

49. *Arrhythmica semifusca* n.sp.

semifuscus, half-dark.

♂. 18-22 mm. Head whitish. Palpi fuscous or grey. Antennae fuscous; ciliations in male 1½. Thorax fuscous; patagia, apices of tegulae, and a posterior spot whitish. Abdomen fuscous; tuft pale ochreous. Legs grey; posterior pair whitish-ochreous. Forewings narrowly triangular, costa gently arched, apex rounded, termen slightly rounded, oblique; white with fuscous markings; an irregular broad costal streak from base usually to ⅓; a very short narrow basal streak on dorsum; a median fascia, its anterior edge connected with costal streak above middle, with a small tooth below middle, ending on mid-dorsum, posterior edge irregular and concave below middle; a sub-terminal fascia from before apex to tornus, its anterior edge angled, posterior edge with apical and subapical white spots; cilia fuscous, on spots whitish. Hindwings with termen slightly sinuate; pale ochreous; a broad terminal fuscous band narrowing to tornus; cilia pale ochreous.

West Australia: Denmark in March and April; five specimens received from Mr. W. B. Barnard, who has the type.

28. Gen. GONIOSEMA.

Turn. Trans, Roy Soc. S.A., 1899, p. 19.

Tongue well developed. Palpi ascending, short, smooth, slender, acute. Antennae in male bipectinate to near apex. Posterior tibiae with middle spurs. Forewings with 2 from towards angle, 3 and 4 stalked, 5 absent, 6 from below upper angle, 7, 8, 10 stalked, 9 absent, 11 from towards end of cell, free. Hindwings in male with cell short (⅓) and with a costal expansion; 2 from near angle, 3 and 4 stalked. 5 somewhat approximated, 6 and 7 stalked, 12 anastomosing to beyond middle of cell. Type, *G. anguliscripta.* Hampson unites this with the monotypical Papuan genus *Licnoptera,* but there are many differences in the secondary sexual characters.

50. *Goniosema anguliscripta.*

Chiriphe anguliscripta Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1079.

Goniosema anguliscripta Turn. Trans. Roy. Soc. S.A., 1899, p. 19.

Licnoptera anguliscripta Hmps. ii., p. 333.

Queensland: Herberton; Brisbane; Toowoomba; Bunya Mountains. New South Wales: Lismore; Allyn River.

51. *Goniosema euraphota* n.sp.

εὐραφοτος, embroidered.

♂. 16-18 mm. Head ochreous-whitish. Palpi 1½; fuscous. Antennae dark fuscous; pectinations in male 6. Thorax fuscous; patagia, apices of tegulae and a posterior spot ochreous-whitish. Abdomen grey; tuft ochreous-whitish. Legs ochreous-whitish; anterior pair grey. Forewings suboval, costa moderately arched, apex rounded, termen straight, oblique; ochreous-whitish with fuscous markings; a basal costal spot; a large elongate median costal spot; from this a sinuate line to ⅓ dorsum; a fine dentate line from beneath ⅘ costa to ⅗ dorsum;

space between lines fuscous on dorsum; a large terminal blotch containing a whitish apical dot; cilia fuscous, on apex and above tornus whitish. Hindwings with termen rounded; grey; cilia grey.

North Queensland: Ravenshoe in December and January; four specimens received from Mr. F. P. Dodd.

29. Gen. ATELOPHLEPS nov.

ἀτελοφλεψ, imperfectly veined.

Tongue present. Palpi very short, slender, ascending. Antennae in male with cilia and bristles. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$, 3 and 4 separate, 5 absent, 6 from upper angle, 7, 8, 10 stalked, 9 absent, 10 separating before 7, 11 from end of cell, free. Hindwings with 2 from angle, connate with 3 and 4, which are stalked, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell.

Characterised by the absence of vein 9 in the forewing and 5 in both wings. Though not closely allied, it is probably a derivative of *Halone*.

52. *Atelophleps tridesma* n.sp.

τριδεσμος, three-banded.

♂. 18 mm. Head ochreous-whitish. Palpi fuscous. Antennae fuscous; ciliations in male $\frac{1}{2}$, bristles 1. Thorax fuscous; patagia and a posterior spot ochreous-whitish. Abdomen fuscous; tuft grey-whitish. Legs ochreous-whitish; anterior pair fuscous with whitish rings. Forewings suboval, costa gently arched, apex rounded, termen slightly rounded, oblique; white with three dark fuscous transverse fasciae; first sub-basal, broader on dorsum; second median, near dorsum dividing into two lines enclosing a white spot; third from $\frac{4}{5}$ costa to tornus, S-shaped; cilia fuscous. Hindwings with termen rounded; grey; cilia grey.

North Queensland: Lake Barrine in May; one specimen.

30. Gen. SCAPHIDRIOTIS.

Turn. Trans. Roy. Soc. S.A., 1899, p. 14. Hmps. ii., p. 496.

Tongue present. Palpi moderately long, ascending; second joint with long spreading hairs in front; terminal joint concealed. Antennae in male with cilia and bristles; basal third with a ridge of scales on upper surface. Posterior tibiae with two pairs of long spurs. Thorax in male with very long tegulae. Forewings in female with 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 separate; in male with 2 and 3 stalked from angle, 4 and 5 absent, 6 from beneath upper angle; 7, 8, 9 stalked, 9 separating before 7, 10 from end of cell, 11 from towards end, free. Hindwings with 2 from towards angle, 3 and 4 coincident, 5 separate, 6 and 7 stalked, 12 anastomosing with cell to middle or beyond. Type, *S. xylogramma*. Monotypical.

53. *Scaphidriotis xylogramma.*

Scaphidriotis xylogramma Turn. Trans. Roy. Soc. S.A., 1899, p. 14. Hmps. ii., p. 496.

Antennae in male with basal joint very stout and long, beyond this a dense ridge of scales above hollowed anteriorly; ciliations 1, bristles

1½. Forewings with antemedian line indented beneath costa and above dorsum; postmedian curved from midcosta to near tornus, with long acute dentations. Hindwings in male with a large patch of fuscous androconia in cell.

Queensland: Kuranda; Atherton Tableland; Macpherson Range (3,000-2,500 feet); Brisbane. New South Wales: Allyn River.

31. Geu. POLIODULE.

Hmps. ii., p. 339.

Tongue absent. Palpi very short, porrect or drooping. Antennae of male bipectinate to apex. Posterior tibiae without middle spurs; terminal spurs short. Forewings with 2 from near angle, 3 from angle, 4 and 5 connate or short-stalked, 6 and 7 connate or stalked, 8 and 9 absent, 10 and 11 from towards end of cell, free. Hindwings with 2 from ⅔, 3 and 4 connate, 5 approximated, 6 and 7 stalked, 12 anastomosing with cell to ⅓. Type, *P. xanthodelta.* Only two species are known. The females are probably apterous.

54. Poliodule poliotricha n.sp.

πολιοτριχος, grey-haired.

♂. 18 mm. Head and palpi fuscous. Antennae dark fuscous; pectinations in male 8. Thorax fuscous; patagia pale ochreous. Abdomen ochreous. Legs fuscous. Forewings narrow, strongly dilated, costa straight, apex rounded, termen obliquely rounded; fuscous with the terminal area densely clothed with grey-whitish hairs; a broad pale ochreous streak from base to ⅔, interrupted at ¼, two large longitudinally oval median pale ochreous spots connected with each other and with costal streak; cilia grey-whitish, apices fuscous. Hindwings broad (nearly 2); termen gently rounded; yellow; a broad fuscous terminal band excavated above and below middle; cilia grey-whitish, on dorsum yellow.

Queensland: Mitchell and Cunnamulla in September; two specimens.

55. Poliodule xanthodelta.

Scoliacma xanthodelta Low. Proc. Lin. Soc. N.S.W., 1897, p. 10.

Poliodule xanthodelta Hmps. ii., p. 340.

New South Wales: Broken Hill.

32. Gen. SYMMETRODES.

Meyr. Proc. Lin. Soc. N.S.W., 1886, p. 703. Hmps. ii., p. 258.

Tongue present. Palpi short, porrect. Antennae of male with cilia and bristles. Forewings with 2 from middle, 3, 4, 5, 6 separate, 7, 8, 9 stalked, 9 separating before 7, 10 from near end of cell, 11 from towards end, anastomosing with 12. Hindwings with 2 from ¾, 3 from angle, connate with 4 and 5, which are stalked, 6 and 7 stalked, 12 anastomosing to beyond middle of cell. Type, *S. sciocosma* Meyr. Allied to *Asura.* Endemic.

56. Symmetrodes sciocosma.

Symmetrodes nitens Meyr. Proc. Lin. Soc. N.S.W., 1886, p. 703, *nec.* Wlk.

Symmetrodes sciocosma Meyr. ibid., 1888, p. 920. Hmps. ii., p. 258, Pl. xxv., f. 15.

I do not know this species.

Queensland.

57. Symmetrodes platymelas n.sp.

πλατυμελας, broadly black.

♂. 24 mm. Head ochreous-yellow. Palpi 1; fuscous. Antennae grey; ciliations in male 1, bristles 1. Thorax yellow with large central blackish spot. Abdomen ochreous-yellow. Forelegs fuscous; (middle and posterior pairs missing). Forewings suboval, costa moderately arched, apex rounded, termen rounded, oblique; ochreous-yellow; markings black; a basal dot; a moderate fascia, angled posteriorly, from $\frac{1}{4}$ costa to $\frac{1}{4}$ dorsum; a broad subterminal band, anterior edge from $\frac{3}{5}$ costa to $\frac{3}{5}$ dorsum, with an acute subdorsal tooth; a yellow dot at $\frac{4}{5}$ costa and small yellow spots at apex, midtermen and tornus; cilia blackish. Hindwings with termen rounded; ochreous-yellow from base to middle; a broad blackish terminal band; cilia blackish.

North Queensland: Ravenshoe in March; one specimen received from Mr. W. B. Barnard, who has the type.

33. Gen. CHIONAEMA.

H-Sch. Ausser Schmet., p. 20. Hmps. ii., p. 296.

Tongue well developed. Palpi short, porrect or ascending; second joint thickened with appressed scales. Antennae in male with minute ciliations and longer bristles. Posterior tibiae with middle spurs. Forewings with 2 from middle or towards angle, 3 and 4 separate, connate, or stalked, 5 from above middle in male below middle in female, 6 separate or stalked, 7, 8, 9 stalked or 9 absent, 10 from near end of cell, 11 from $\frac{2}{3}$ or towards angle, free. Hindwings with 2 from near angle, 3 and 4 stalked or coincident, 5 from middle or from below middle, weakly developed, 6 and 7 stalked, 12 anastomosing to $\frac{1}{3}$ or to middle. Type, *C. puella* Drury. A genus largely developed in the Eastern Tropics. It presents considerable variation in neuration, which is sometimes sexual.

58. Chionaema obscura.

Chionaema obscura Hmps. ii., p. 301.

Forewings with 2 from near middle; in male 3 and 4 are remote at origin, but fuse together before reaching termen; in male, there is a large oval subcostal gland before and beyond end of cell beneath. Hindwings with 3 and 4 coincident.

North Queensland: Cape York; Cairns.

59. Chionaema meyricki.

Exotrocha liboria Meyr. l.c., p. 693, *nec* Cramer.

Clerckia meyricki Roths. Nov. Zool., viii., p. 410.

Chionaema meyricci Hmps. Suppl. i., p. 616.

Forewings with 3 and 4 connate or stalked; 6 stalked with 7 and 8; in male a triangular glandular subcostal flap beyond cell beneath. Hindwings with 3 and 4 stalked.

Queensland: Cairns; Mackay; Brisbane; Mount Tamborine; Tweed Heads. New South Wales: Lismore; Newcastle.

60. *Chionaema asticta.*

Chionaema asticta Hmps. Suppl. i., p. 636.

I do not know this species.

North Queensland: Cairns.

34. Gen. EUTANE.

Wlk. ii., 531. Hmps. ii., p. 495.

Tongue well developed. Palpi short, porrect or ascending; second joint hairy; terminal joint short, obtusely pointed. Antennae in male minutely ciliated. Posterior tibiae with spurs normal. Forewings with 2 from $\frac{2}{3}$ or $\frac{3}{4}$, 3, 4, 5 separate, 6 from beneath upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 connate or stalked with them, 11 from towards end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 stalked, 5 remote, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *E. terminalis.* There is also one species from New Guinea and one from Borneo.

Structurally this genus is allied to *Hectobrocha*; superficially it is very different. The type species has been attracted into the synaposematic group, which includes *Asura* and *Syntomis.*

61. *Eutane terminalis.*

Wlk. ii., p. 531. Meyr. l.c., p. 746. Hmps. ii., p. 495.

Eutane maculata Butl. Trans. Ent. Soc., 1877, p. 335.

Queensland: Gayndah; Maryborough; Brisbane; Macpherson Range; Toowoomba; Warwick. New South Wales: Newcastle; Sydney.

62. *Eutane trimochla* n.sp.

τριμοχλος, three-barred.

♂ ♀. 22-27 mm. Head yellow, sometimes orange on crown. Palpi 1; dark fuscous. Antennae fuscous, towards apex yellowish; ciliations in male $\frac{2}{3}$, bristles 1. Thorax dark fuscous; patagia, bases of tegulae, and anterior and posterior spots yellow or orange. Abdomen dark fuscous; tuft and usually apices of segments orange. Legs dark fuscous with yellow rings; posterior pair ochreous. Forewings elongate triangular, costa slightly arched, apex rounded, termen oblique; yellow with dark fuscous markings; a narrow basal fascia produced on costal edge to middle; three broad transverse lines; first at $\frac{1}{4}$, outwardly curved; second median, slightly waved; third from $\frac{2}{3}$ costa to tornus; a dot on costa beyond this; a strongly waved line from apex to tornus touching termen in middle; sometimes interrupted; cilia yellow, on apex and tornus dark fuscous. Hindwings with termen rounded; yellow; a broad dark fuscous terminal band; cilia yellow, towards tornus fuscous.

Queensland: Injune in March and April; six specimens.

35. Gen. HECTOBROCHA.

Meyr. l.c., p. 706. Hmps. ii., p. 497.

Tongue well developed. Palpi moderately long, porrect obtuse. Antennae of male with ciliations and bristles. Posterior tibiae with spurs normal. Forewings with 2 from middle, 3 and 4 coincident and 5 remote in male; 3 from well before angle, 4 separate, and 5 remote in female; 6 from or from beneath upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 connate or stalked with them, 11 from $\frac{2}{3}$, free. Hindwings with 2 from $\frac{3}{5}$, 3 and 4 stalked, 5 widely separate, 6 and 7 stalked, 12 anastomosing with cell to $\frac{1}{3}$. Type, *H. pentacyma*. *Neobrocha* Meyr. cannot be separated from this genus. Endemic.

63. *Hectobrocha pentacyma.*

Hectobrocha pentacyma Meyr. l.c., p. 707. Hmps. ii., p. 497.

Hectobrocha multilinea Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1072. Hmps. ii., p. 498, Pl. 33, f. 1.

Northern specimens are usually larger, the forewings more tinged with yellow, and the markings coarser.

Queensland: Blackbutt; Brisbane; Mount Tamborine; Macpherson Range (2,500 feet); Toowoomba. New South Wales: Lismore; Gosford; Sydney.

64. *Hectobrocha phaeocyma.*

Neobrocha phaeocyma Meyr. l.c., p. 708. Hmps. ii., p. 498, Pl. 33, f. 2,

This species is unknown to me.

North Queensland: Thursday Island.

65. *Hectobrocha adoxa.*

Neobrocha adoxa Meyr. l.c., p. 708. Hmps. ii., p. 499.

Hectobrocha subnigra Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1072.

Eutane subnigra Hmps. Suppl. i., p. 786, Pl. 41, f. 8.

♂ ♀. 28-38 mm. Head whitish-brown. Palpi $1\frac{1}{2}$; dark fuscous. Antennae pale grey; ciliations in male $\frac{1}{2}$, bristles 2. Thorax whitish-brown; bases of tegulae, two anterior dots, and a posterior spot fuscous. Abdomen brown-whitish, Legs fuscous with brown-whitish bands; posterior tibiae brown-whitish. Forewings triangular, costa strongly arched, apex rounded, termen slightly rounded, slightly oblique; brown-whitish with fuscous markings; two blackish sub-basal dots connected with a sub-basal spot on costa; a line from $\frac{1}{4}$ costa outwardly curved to $\frac{1}{3}$ dorsum with long acute dentations, which interlace with those of a following line from $\frac{2}{5}$ costa to mid-dorsum; between these lines is a blackish dot; two blackish dots placed obliquely in disc beyond middle; two strongly dentate interlacing postmedian lines; a strongly dentate subterminal line; cilia brown-whitish bases partly fuscous.

Queensland: Brisbane; Bunya Mountains. New South Wales: Sydney.

36. Gen. TRISSOBROCHA.

Turn. Proc. Lin. Soc. N.S.W., 1914, p. 548.

Tongue well developed. Palpi moderately long, ascending, smooth, slender, acute. Antennae in male with cilia and bristles. Posterior tibiae with spurs normal. Forewings with 2 from $\frac{3}{4}$, 3, 4, 5 separate,

6 from beneath upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from well before end of cell, 11 from $\frac{3}{4}$, free. Hindwings with 2 from near angle, 3 and 4 stalked, 5 remote, 6 and 7 stalked, 12 anastomosing with cell to $\frac{1}{4}$. Monotypical.

The neuration shows that this is nearly allied to *Hectobrocha*, but is less specialised. The neutration described is that of the male. The female is unknown, but should show no difference.

66. Trissobrocha eugraphica.

Trissobrocha eugraphica Turn. Proc. Lin. Soc. N.S.W., 1914, p. 548.

Queensland: Macpherson Range (3,500 feet). New South Wales: Ebor; Barrington Tops.

37. Gen. AMELETA nov.

ἀμελητος, uncared for.

Tongue present. Palpi rather long, curved, ascending, slender, acute. Antennae in male with cilia and bristles. Forewings with 2 from middle, 3 and 4 stalked from angle, 5 approximated, 6 from below upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from $\frac{3}{4}$, 11 from middle, free. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 coincident, 5 curved at base and approximated to 3, 4, 6, and 7 stalked, 12 anastomosing with cell to $\frac{2}{3}$.

67. Ameleta panochra n.sp.

πανωχρος, wholly pale.

♂. 16 mm. Head and thorax pale grey. Palpi $1\frac{1}{2}$; grey-whitish. Antennae grey-whitish; ciliations in male $\frac{1}{2}$, bristles 1. Abdomen grey-whitish. Legs grey. Forewings narrow, suboblong, costa arched to $\frac{1}{4}$, thence straight, apex rounded, termen slightly rounded, oblique; whitish with slight patchy grey irroration; fuscous discal dots at $\frac{1}{3}$ and beyond $\frac{2}{3}$; some grey suffusion above $\frac{1}{3}$ and $\frac{2}{3}$ dorsum and forming two interrupted transverse lines in terminal area; cilia whitish. Hindwings with termen slightly rounded; whitish; cilia whitish.

Extremely similar to *Aclytophanes aedumena*; distinguishable by the neuration and longer palpi.

North Queensland: Kuranda in October; one specimen received from Mr. F. P. Dodd.

38. Gen. HELIOSIA.

Hmps. ii., p. 275.

Tongue present. Palpi moderately long, ascending, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. forewings with 2 from middle, 3 and 4 stalked, 5 separate, 6 from near upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from before end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from towards angle, 3 and 4 stalked or coincident, 5 from below middle of cell, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *H. jucunda.* Mostly Papuan with stragglers in Borneo and China.

The hindwings have 3 and 4 stalked in *charopa,* coincident in the other three species.

68. Heliosia micra.

Heliosia micra Hmps. Suppl. i., p. 585, Pl. 31, f. 8.

North Queensland: Cooktown; Cairns; Innisfail.

69. Heliosia jucunda.

Pallene jucunda Wlk. ii., p. 543.

Mosoda jucunda Meyr. l.c., p. 728.

Heliosia jucunda Hmps. ii., p. 275.

Tospitis transitana Wlk., xxviii., p. 430.

Queensland: Herberton; Duaringa; Gayndah; Nambour; Brisbane; Stanthorpe; Milmerran. New South Wales: Glen Innes, Murrurundi; Sydney.

70. Heliosia charopa.

Heliosia charopa Turn. Trans. Roy. Soc. S.A., 1904, p. 212. Hmps. Suppl. i., p. 586.

North Queensland: Herberton; Townsville.

39. Gen. ACLYTOPHANES nov.

ἀκλυτοφανης, unrenowned.

Tongue present. Palpi moderately long, slender, porrect or ascending. Antennae with cilia and bristles in both sexes. Forewings with 2 from middle, 3 from near before angle, 4 and 5 stalked, 6 from above middle, 7, 8, 9 stalked, 9 separating before 7, 10 from well before end of cell, 11 from near middle, free. Hindwings with 2 from near angle, 4 absent, 3 and 5 stalked, 6 and 7 stalked, 12 anastomosing to middle of cell.

Allied to *Scaptesyle.*

71. Aclytophanes aedumena.

Heliosia aedumena Turn. Proc. Roy. S. Vic., 1922, p. 29.

North Queensland: Cairns; Kuranda; Lake Barrine.

40. Gen. SCAPTESYLE.

Wlk. ii., 378. Hmps. ii., p. 283.

Tongue present. Palpi moderate, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{4}{5}$, 3 from angle, 4 and 5 stalked, 6 stalked with 7 or from below angle, 7, 8, 9 stalked, 9 separating before 7, 10 from end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from middle, 3 and 4 stalked, 5 from middle or below, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *S. tricolor* Wlk. from India and Malay Archipelago. A small Indo-malayan and Australian genus. *Chiriphe* Wlk. is a synonym.

Vein 6 of the forewings is stalked in *dictyota* and *dichotoma*, separate in *aequidistans, tetramita*, and *monogrammaria.*

Key to Species.

1. Thorax white anteriorly	2	
Thorax not white anteriorly	3	
2. Forewings with antemedian and postmedian lines connected by a line in disc		*dichotoma*
Forewings with antemedian and postmedian lines connected on costa only		*dictyota*
3. Forewings yellow	4	
Forewings brown		*monogrammaria*
4. Hindwings with a fuscous band reaching tornus ..		*aequidistans*
Hindwings with an apical fuscous blotch nor reaching beyond middle		*tetramita*

72. Scaptesyle dictyota.

Chiriphe dictyota Meyr. l.c., p. 735.
Scaptesyle dictyota Hmps. ii., p. 286, Pl. 26, f. 21.

Queensland: Brisbane; Toowoomba. New South Wales: Allyn River.

73. Scaptesyle dichotoma.

Chiriphe dichotoma Meyr. l.c., p. 734.

Scaptesyle dichotoma Hmps. ii., p. 283.

North Queensland: Cairns; Lake Barrine; Herberton. Queensland: Brisbane; Stradbroke Island; Mount Tamborine; Tweed Heads; Rosewood; Toowoomba; Warwick. New South Wales: Sydney. Victoria: ———.

74. Scaptesyle aequidistans.

Comarchis aequidistans Luc. Proc. Lin. Soc. N.S.W., 1890, p. 1080.
Scaptesyle aequidistans Hmps. ii., p. 285, Pl. 26, f. 30.

Queensland: Brisbane; Stanthorpe. New South Wales: Murrurundi.

75. Scaptesyle tetramita n.sp.

τετραμιτος, four-lined.

♀. 28-29 mm. Head whitish. Palpi 1; fuscous. Antennae pale grey. Thorax whitish-ochreous, anterior third fuscous. Abdomen pale ochreous. Legs fuscous with whitish rings; posterior pair ochreous-whitish. Forewings narrowly triangular, costa slightly arched, apex pointed, termen straight, slightly oblique; whitish-ochreous with fuscous markings; an incomplete transverse line from costa near base; a line from $\frac{1}{5}$ costa to $\frac{1}{5}$ dorsum; a line from $\frac{2}{5}$ costa to $\frac{2}{5}$ dorsum, preceded by and sometimes confluent with a discal dot; a third line from $\frac{3}{4}$ costa to $\frac{4}{5}$ dorsum, preceded by a partly confluent discal dot; fourth line subterminal, somewhat dentate; cilia whitish-ochreous. Hindwings with termen rounded; pale ochreous; a fuscous apical blotch prolonged along termen to middle; cilia pale ochreous.

New South Wales: Warral near Tamworth, in April; two specimens received from Mr. Geo. Lyell, who has the type.

76. Scaptesyle monogrammaria.

Chiriphe monogrammaria Wlk., xxvi., p. 1692. Meyr. l.c., p. 734.

Scaptesyle monogrammaria Hmps. ii., p. 286, Pl. 26, f. 22.

Queensland: Nanango; Brisbane; Toowoomba; Bunya Mountains; Stanthorpe; Milmerran; Inglewood. New South Wales: Tabulam; Glen Innes; Armidale; Ebor; Murrurundi; Sydney; Jervis Bay; Moruya.

41. Gen. HALONE.

Wlk. ii., p. 450. Hmps. ii., p. 276.

Tongue present. Palpi moderately long, porrect or ascending, slender, acute. Antennae in male ciliated or shortly pectinated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$ to $\frac{4}{5}$, 3, 4, 5 remote, 6 from below upper angle, 7, 8, 9 stalked, 9 separating

before 7, 10 from before end of cell, 11 from $\frac{2}{3}$ or after, free. Hindwings with 2 from $\frac{2}{3}$ or from well before angle, 3 and 4 coincident, 5 separate, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *H. sobria*. *Mosada* Wlk. is a synonym. There are two Indian species.

KEY TO SPECIES.

1. Hindwings orange-yellow with dark fuscous apical spot	2	
Hindwings not so	3	
2. Hindwings with dark fuscous tornal spot ..		*sinuata*
Hindwings without tornal spot		*coryphaea*
3. Hindwings pale ochreous	4	
Hindwings grey	6	
4. Forewings with ground-colour fuscous		*sobria*
Forewings with ground-colour white or whitish ..	5	
5. Forewings with sub-basal and terminal areas broadly whitish		*epiopsis*
Forewings with these areas narrowly white ..		*ophiodes*
6. Forewings with white costal spot at $\frac{2}{3}$		*pteridaula*
Forewings without white costal spot	7	
7. Size minute; marking reduced to dots		*ebaea*
Size moderate; forewings with transverse lines or fasciae	8	
8. Forewings with dark terminal band		*sejuncta*
Forewings without terminal band	9	
9. Forewing cilia with fuscous bars	10	
Forewing cilia not barred with fuscous		*interspersa*
10. Forwings with posterior edge of median fascia twice bent rectangularly		*proscnes*
Forewings with median fascia not so formed ..		*servilis*

77. *Halone sinuata.*

Setina sinuata Wlgrn. Wien. Ent. Mon. 1860, p. 46.

Halone sinuata Hmps. ii., p. 278.

Mosoda anartioides Wlk., xxxv., p. 1900. Meyr. l.c., p. 128.

New South Wales: Sydney; Katoomba; Jervis Bay.

78. *Halone coryphaea.*

Halone coryphaea Turn. Proc. Roy. Soc. Q. 1915, p. 17. Hmps., Suppl., Pd. 31, f. 14.

Queensland: Toowoomba; Warwick; Stanthorpe; Macpherson Range, 2,000 feet. New South Wales: Tenterfield; Glen Innes; Ebor; Murrurundi; Moruya; Bathurst; Mount Kosciusko, 4,500 feet. Victoria: Beechworth; Mount Buffalo; Melbourne.

79. *Halone sobria.*

Halone sobria Wlk. ii., p. 540. Hmps. ii., p. 278.

Mosoda consolatrix Rosen. Ann. Mag. Nat. Hist. (5), xvi., p. 381.

Mosoda hemichroa Turn. Trans. Roy. Soc. S.A. 1899, p. 18.
Victoria: Gisborne.

80. *Halone epiopsis* n. sp.

ἠπιοψις, soft, gentle.

♂ ♀. 22-30 mm. Head and thorax whitish-grey. Palpi $1\frac{1}{4}$; fuscous. Antennae pale grey; in male with short slender pectinations (1) ending

in tufts of cilia. Abdomen whitish-ochreous. Legs fuscous with whitish-ochreous rings; posterior pair whitish-ochreous. Forewings elongate-triangular, costa gently arched, apex rounded, termen obliquely rounded; whitish-ochreous with fuscous markings; a sub-basal transverse line angled posteriorly; a line from $\frac{2}{5}$ costa to mid-dorsum, irregularly dentate with a small rounded median process; another from $\frac{2}{3}$ costa to before tornus, more strongly dentate; median area more or less suffused with fuscous and containing a fuscous discal spot; a subterminal shade, strongly dentate and touching termen in middle; cilia whitish-ochreous with fuscous bars. Hindwings with termen rounded; whitish-ochreous; a fain grey postmedian line; cilia ochreous-whitish.

Queensland: Stanthorpe in October and November; ten specimens.

81. *Halone ophiodes.*

Mosoda ophiodes Meyr. l.c., p. 729.

Halone ophiodes Hmps. ii., p. 277, Pl. 26, f. 8.

Victoria: Castlemaine; Beaconsfield.

82. *Halone ebaea.*

Halone ebaea Hmps. Suppl. i., p. 589, Pl. 31. f. 16. Turn., Proc. Roy. Soc. Q., 1915, p. 18.

North Queensland: Cairns; Innisfail; Atherton Plateau.

83. *Halone pteridaula.*

Eurypepla pteridaula Turn. Proc. Roy. Soc. Vic., 1922, p. 31.

Queensland: Macpherson Range (2-4,000 feet); Bunya Mountains. New South Wales: Allyn River.

84. *Halone sejuncta.*

Pitane sejuncta Feld. Reis. Nov., Pl. 140, f. 24.

Mosoda sejuncta Meyr. l.c., p. 730.

Halone sejuncta Hmps. ii., p. 277.

Queensland: Herberton; Lake Barrine; Nambour; Brisbane; Mount Tamborine; Macpherson Range, 2,500-3,000 feet; Toowoomba; Warwick; Killarney; Bunya Mountains; Milmerran. New South Wales: Lismore; Ebor; Murrurundi; Gosford; Sydney; Mount Wilson. Victoria: Melbourne. Tasmania: Launceston; Burnie; Derby; St. Helens.

85. *Halone interspersa.*

Sorocostia interspersa Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1076.

Siccia interspersa Hmps. ii., p. 393, Pl. 29, f. 27.

♂ ♀. 16-19 mm. Head and thorax grey. Palpi ascending; grey. Antennae grey; in male with minute ciliations and longer bristles. Abdomen grey; tuft ochreous-whitish. Legs grey; posterior pair ochreous-whitish. Forewings suboval, costa gently arched, apex round-pointed, termen slightly rounded, oblique; whitish partly suffused with grey; markings fuscous; basal and sub-basal fuscous transverse lines; a

broad grey fascia, sometimes containing an angular discal mark, edged by fuscous lines, anterior dentate from $\frac{1}{3}$ costa to mid-dorsum, posterior sharply dentate from $\frac{3}{5}$ costa to $\frac{3}{4}$ dorsum, its medium half forming a rectangular projection; a terminal fascia from $\frac{3}{4}$ costa to dorsum near tornus, its posterior edge sharply dentate, apices of teeth nearly reaching margin; a terminal series of dots; cilia whitish. Hindwings with termen rounded; grey; cilia grey.

Queensland: Cairns; Bundaberg; Brisbane; Tweed Heads; Macpherson Range (Springbrook). New South Wales: Ebor.

86. *Halone prosenes* n.sp.

προσηνης, soft.

♂. 22 mm. Head white. Palpi fuscous. Antennae fuscous; ciliations in male 1. Thorax fuscous with a central white dot; tegulae partly white. Abdomen grey; tuft grey-whitish. Legs fuscous with whitish rings; posterior pair whitish. Forewings narrow, posteriorly strongly dilated, costa gently arched, apex rounded; termen obliquely rounded; white; markings and slight irroration in terminal area fuscous; a small basal fascia constricted on dorsum; a broad median fascia, anterior margin irregularly waved, from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, posterior margin dentate from $\frac{2}{3}$ costa, running close beneath costa to $\frac{5}{6}$, there bent at a right angle to below middle, where it is again bent rectangularly, and is indented above dorsum, on which it ends at $\frac{3}{4}$; in this is a white transverse mark at $\frac{2}{3}$, preceded by two short longitudinal pale streaks; cilia white barred with fuscous except at apices. Hindwings with termen gently rounded; grey-whitish; cilia whitish.

Victoria: Melbourne (Springvale) in November; type in Coll. Barnard.

87. *Halone servilis.*

Mosoda servilis Meyr. l.c., p. 731.

Halone servilis Hmps. ii., p. 279, Pl. 26, f. 11.

Queensland: Herberton; Mount Tamborine; Toowoomba; Killarney; Stanthorpe. New South Wales: Sydney. Victoria: Melbourne.

42. Gen. PSAPHARACIS.

Turn. Trans. Roy. Soc. S.A., 1890, p. 14.

Tongue well developed. Palpi short, ascending, slender, acute. Antennae of male moderately ciliated. Posterior tibiae with middle spurs. Forewings with costa strongly bent or angled beyond middle; 2 from near angle, 3, 4, 5 separate, 6 from below upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from before end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from near angle, 3 and 4 stalked or coincident, 5 from middle, 6 and 7 stalked, 12 anastomosing with cell to middle. Type, *P. toxophora* Turn. A Papuan genus. Allied to *Macaduma* Wlk., in which 9 of forewings is absent.

88. *Psapharacis toxophora.*

Psapharacis toxophora Turn. l.c., p. 15.

Macaduma toxophora Hmps. ii., p. 266.

Queensland: Cooktown; Cairns; Brisbane. New South Wales: Lismore.

89. *Psapharacis pallicosta.*

Macaduma pallicosta Roths. Nov. Zool., 1912, p. 236. Hmps., Suppl. i., p. 575.

I do not know this and the following species.

North Queensland: Mackay.

90. *Psapharacis albisparsa.*

Macaduma albisparsa Hmps. Suppl. i., p. 575.

North Queensland: Kuranda. Also from New Guinea.

91. *Psapharacis strongyla.*

Macaduma strongyla Turn. Proc. Roy. Soc. Vic., 1922, p. 30.

North Queensland: Kuranda; Ravenshoe; Palm Island.

92. *Psapharacis picroptila.*

Macaduma picroptila Hmps. Suppl. i., p. 580.

Queensland: Nambour; Brisbane; Macpherson Range, 3,000 feet; Toowoomba; Bunya Mountains.

93. *Psapharacis camptopleura* n. sp.

καμπτοπλευρος, with bent costa.

♂. 17 mm. Head, palpi, and thorax pale grey. Antennae fuscous; ciliations in male $\frac{1}{2}$. Abdomen fuscous; tuft grey. Legs fuscous; posterior pair whitish. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, there abruptly bent, apex rectangular, termen straight, oblique; pale grey; markings and some scattered scales fuscous; a narrow median fascia expanded on dorsum, anterior edge straight, irregularly dentate, posterior edge ill-defined; a very fine dentate postmedian line angled beneath costa; a large rounded subapical costal spot and a smaller tornal spot; cilia whitish-grey, bases barred with fuscous. Hindwings with termen nearly straight; 3 and 4 coincident; grey; cilia grey.

North Queensland: Lake Barrine in June; one specimen.

43. Gen. CAPRIMIMA.

Caprima Hmps. ii., p. 286, *nec.* Wlk.

Caprimima Hmps. ii., p. 561.

Tongue present. Palpi moderate, porrect or ascending, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{4}{5}$, 3 and 4 separate, the latter sometimes approximated to 5, 6 separate, 7, 8, 9 stalked, 9 separating before 7, 10 from end of cell, 11 from $\frac{3}{4}$, free. Hindwings with 2 from near or towards angle, 3 and 4 stalked, 5 from below middle, 6 and 7 stalked, 12 anastomosing to $\frac{1}{3}$ or middle of cell. Type, *C. albicollis* Pagent. from New Guinea. A Papuan genus.

KEY TO SPECIES.

1.	Hindwings orange-brown		*procrena*
	Hindwings not orange-brown	2	
2.	Forewings fuscous with white lines		*catarrhoa*
	Forewings not so	3	
3.	Fore and hindwings dark brown		*pelochroa*
	Fore and hindwings not brown	4	
4.	Hindwings grey		*sicciodes*
	Hindwings whitish	5	
5.	Forewings with blackish dotted lines		*scripta*
	Forewings with pale fuscous slender lines ..		*leptomita*

94. *Caprimima procrena.*

Chiriphe procrena Meyr. l.c., p. 733.

Caprima procrena Hmps. ii., p. 288, Pl. 26, f. 4.

New South Wales: Mount Kosciusko, 3,500 feet. Victoria: Melbourne; Gisborne. Tasmania: Deloraine; Wilmot; Rosebery; Strahan; Cradle Mountain, 2,000 feet; Russell Falls; Lake Fenton, 3,500 feet.

95. *Caprimima catarrhoa.*

Chiriphe catarrhoa Meyr. l.c., p. 733.

Caprima catarrhoa Hmps. ii., p. 289.

West Australia: Albany.

96. *Caprimima pelochroa.*

Caprimima pelochroa Hmps. Suppl. i., p. 611, Pl. 32, f. 16.

Queensland: Ravenshoe; Eungella; Brisbane; Macpherson Range; Killarney. New South Wales: Gosford; Bulli.

97. *Caprimima sicciodes.*

Caprimima sicciodes Hmps. Suppl. i., p. 611, Pl. 32, f. 36.

♂ ♀. 18-28 mm. Head and thorax grey. Palpi 1½; fuscous. Antennae grey; ciliations in male 2. Abdomen grey; tuft pale ochreous-grey. Legs fuscous with ochreous-whitish rings; posterior pair paler. Forewings suboval, costa strongly arched, apex rounded, termen scarcely rounded, slightly oblique; pale ochreous-grey with some fuscous irroration; markings dark fuscous; an interrupted dentate sub-basal line not reaching dorsum; a thick slightly dentate line from ⅓ costa to ⅓ dorsum, becoming slender towards dorsum; a pale-centred discal dot; quadrangular costa spots at ⅔ and ⅚, from which proceed finely dentate lines to ¾ dorsum; cilia ochreous-grey with some fuscous bars. Hindwings with termen rounded; grey; cilia pale ochreous-grey.

Tasmania: Launceston; Cradle Mountain (2,000 feet); Waratah; Strahan; Russell Falls; Mount Wellington (1,500-2,500 feet); not uncommon.

98. *Caprimima scripta.*

Caprimima scripta Low. Proc. Lin. Soc. N.S.W,. 1901, p. 640. Hmps., Suppl. i., p. 611, Pl. 32, f. 17.

♂. 19-20 mm. Head white. Palpi 1¼; fuscous. Antennae grey; ciliations in male 1. Thorax fuscous; patagia and tegulae white.

Abdomen fuscous; tuft whitish. Legs fuscous; posterior pair whitish. Forewings moderately broad, posteriorly dilated, costa moderately arched, apex subrectangular, termen slightly rounded, slightly oblique; white with dark fuscous markings; a sub-basal dot; a basal costal dot and another at $\frac{1}{6}$, costal edge between these fuscous; a costal dot at $\frac{1}{3}$, from which a very fine dotted line proceeds to $\frac{1}{3}$ dorsum, and is preceded by dorsal and subdorsal dots; a dot on $\frac{2}{3}$ costa, from which is a very fine dentate and dotted line to $\frac{2}{3}$ dorsum, bent outwards above and inwards below middle; an interrupted dotted subterminal and similar submarginal line; cilia whitish, on midtermen fuscous. Hindwings with termen rounded; grey-whitish; cilia whitish.

Queensland: Stannary Hills, near Herberton; Yeppoon; Duaringa.

99. *Caprimima leptosema* n. sp.

λεπτοσημος, slenderly marked.

♂ ♀. 18-22 mm. Head, palpi, and thorax whitish. Antennae whitish; ciliations in male 1. Abdomen grey-whitish. Legs whitish; anterior pair pale grey. Forewings suboval, costa rather strongly arched, apex rounded, termen obliquely rounded; whitish; markings fuscous; a sub-basal dot; a basal costal dot and another shortly beyond; a double antemedian line at $\frac{1}{3}$ becoming obsolete towards dorsum; a pale-centred median discal dot; an irregularly dentate postmedian line from $\frac{2}{3}$ costa outwards, soon becoming transverse, below middle bent outwards, ending on $\frac{3}{4}$ dorsum; a suffused and interrupted subterminal line; a subapical dot and another on termen above middle, sometimes connected; a tornal dot; cilia whitish, on marking fuscous. Hindwings with termen gently rounded; grey-whitish; cilia whitish.

Queensland: Montville, near Nambour, in October. New South Wales: Lismore in October. Two specimens.

44. Gen. THALLARCHA.

Meyr. l.c., p. 736. Hmps. ii., p. 499.

Tongue well developed. Palpi short or moderately long, ascending, smooth, slender, acute. Antennae in male usually bipectinate to apex, pectinations moderate or short, rarely with fascicles of cilia only. Posterior tibiae with two pairs of long spurs. Forewings with 2 from middle or $\frac{3}{4}$, 3, 4, 5 separate, 6 from below upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from before end of cell, 11 from $\frac{3}{4}$, free. Hindwings with 2 from $\frac{2}{3}$ or near angle, 3 and 4 approximated or connate, 5 remote, 6 and 7 stalked, 12 anastomosing with cell to $\frac{2}{3}$ or further. Type, *T. phalarota*.

A comparatively large genus wholly endemic. *Comarchis* Meyr. cannot be retained as a distinct genus. The species referred here mostly have the male antennae pectinated, though it may be very shortly as in *isophragma* and *chrysochroa*, only rarely are the pectinations replaced by fascicles of cilia as in *jocularis*.

KEY TO SPECIES.

1.	Hindwings without distinct discal dot	2	
	Hindwings with discal dot	15	
2.	Thorax wholly white	3	
	Thorax not wholly white	4	
3.	Hindwings yellow		*epigypsa*
	Hindwings whitish or grey		*epileuca*
4.	Hindwings grey	5	
	Hindwings not grey	8	
5.	Forewings fuscous with white or yellow markings	6	
	Forewings whitish with fuscous or blackish dots or lines	7	
6.	Head whitish		*oosmeta*
	Head yellow		*zophophanes*
7.	Forewings with blackish triradiate tornal spot ..		*macilenta*
	Forewings without blackish tornal spot		*leptographa*
8.	Forewings with large triangular spot on termen		*staurocola*
	Forewings without triangular spot on termen ..	9	
9.	Forewings fuscous with white markings		*phalarota*
	Forewings whitish or yellow with transverse lines or fasciae	10	
10.	Thorax wholly fuscous		*partita*
	Thorax not wholly fuscous	11	
11.	Forewings with transverse fasciae	12	
	Forewings with transverse lines only	15	
12.	Forewings with two fasciae	13	
	Forewings with three fasciae	14	
13.	Forewings with median fascia narrow		*mochlina*
	Forewings with median fascia broad and containing costal and dorsal pale spots		*homoschema*
14.	Forewings with median fascia divided into two lines		*oblita*
	Forewings with median fascia not divided ..		*lochaga*
15.	Forewings with ground colour white		*erotis*
	Forewings with ground colour pale ochreous ..		*stramenticolor*
16.	Forewings grey		*fusa*
	Forewings not grey	17	
17.	Forewings fuscous with white blotches	18	
	Forewings white or yellow with fuscous markings	19	
18.	Hindwings whitish		*epicela*
	Hindwings yellow		*lechrioleuca*
19.	Hindwings broader than forewings	20	
	Hindwings not broader than forewings	21	
20.	Hindwings with termen blackish nearly to tornus		*chrysochoa*
	Hindwings not blackish beneath middle		*jocularis*
21.	Forewings with fuscous terminal dots	22	
	Forewings without terminal dots	24	
22.	Forewings with subapical blackish blotch ..		*sparsana*
	Forewings without subapical blotch	23	
23.	Forewings with median transverse fascia		*catasticta*
	Forewings with transverse lines only		*rhaptophora*
24.	Forewings with reddish-brown markings		*fuscogrisea*
	Forewings with fuscous or blackish markings ..	25	
25.	Forewings with median transverse fascia ..	26	
	Forewings with transverse lines only	29	
26.	Forewings with basal costal streak		*pellax*
	Forewings without basal costal streak	27	
27.	Forewings yellow with blackish fasciae		*chrysochares*
	Forewings white or whitish with fuscous fasciae	28	
28.	Forewings with three fasciae		*trissomochla*
	Forewings with two fasciae		*albicollis*
29.	Forewings with costal streak not reaching middle		*epiostola*
	Forewings with costal streak reaching beyond middle		*isophragma*

100. Thallarcha phalarota.

Thallarcha phalarota Meyr. l.c., p. 736. Hmps. ii., p. 501, Pl. 33, f. 16.

Thallarcha phaedropa Meyr. l.c., p. 737.

Queensland: Bundaberg; Eidsvold; Brisbane; Rosewood; Toowoomba; Killarney; Bunya Mountains; Milmerran. New South Wales: Lismore; Sydney. Victoria: Beechworth; Melbourne; Myrtleford.

101. Thallarcha chrysochares.

Thallarcha chrysochares Meyr. l.c., p. 738. Hmps. ii., p. 499, Pl. 33, f. 3.
Comarchis cosmia Turn. Trans. Roy. Soc. S.A., 1899, p. 19.

Queensland: Brisbane; Milmerran. New South Wales: Murrurundi.

102. Thallarcha albicollis.

Pitane albicollis Feld. Reise Nov., Pl. 140, f. 37.

Thallarcha albicollis Meyr. l.c., p. 737. Hmps. ii., p. 500.

Comarchis chionea Turn. Trans. Roy. Soc. S.A., 1899, p 20.

Queensland: Chinchilla; Charleville. New South Wales: Glen Innes; Sydney. Tasmania: Hobart; Triabunna; Bothwell. South Australia: Mount Lofty.

103. Thallarcha pellax n. sp.

pellax, deceitful.

♂. 24 mm. Head white; face fuscous. Palpi 1; fuscous. Antennae blackish; in male with pectinations very short, each ending in a tuft of long ciliations. Thorax blackish; patagia and apices of tegulae white. Abdomen pale ochreous with a median dorsal seies of fuscous dots. Legs ochreous; anterior pair fuscous. Forewings elongate-oval, costa gently arched, apex round-pointed, termen nearly straight, oblique; white with dark fuscous markings; a broad costal streak from base to $\frac{3}{5}$; a wavy transverse line at $\frac{1}{3}$; a median fascia slender above and thicker below middle, anterior margin indented above dorsum; a costal dot at $\frac{4}{5}$; a terminal band; a dorsal dot at $\frac{4}{5}$ connected with fascia and band; cilia fuscous, on tornus white. Hindwings with termen slightly rounded; pale ochreous; a discal dot and a small apical blotch fuscous; cilia pale ochreous, on apex fuscous.

This species closely resembles *Philenora undulosa* Wlk., of which several were taken at the same locality in the same week.

New South Wales: Ben Lomond, near Guyra, in February; one specimen.

104. Thallarcha cosmodes n. sp.

κοσμώδης, neat.

♀. 18 mm. Head ochreous-whitish. Palpi and antennae fuscous. Thorax fuscous; patagia and a posterior spot ochreous-whitish. Abdomen grey; posterior pair ochreous-whitish. Forewings elongate-triangular, costa moderately arched, apex rounded, termen slightly rounded, oblique; fuscous with white markings; an irregular sub-basal blotch on dorsum to $\frac{1}{3}$, broadest near base, where it reaches near costa, upper surface incurved, posterior angle acute, thence inwardly sinuate; a large triangular spot on midcosta; a smaller triangle on dorsum near tornus; a

very short slender oblique costal streak before apex; cilia fuscous. Hindwings with termen rounded; 12 anastomosing to end of cell and base of vein 7; grey, towards base and dorsum paler and ochreous-tinged; cilia grey.

Queensland: Toowoomba in May; one specimen received from Mr. W. B. Barnard, who has the type.

105. Thallarcha zophophanes n. sp.

ζοφοφανης, dusky.

♂. 16 mm. Head yellow. Palpi fuscous, apices whitish-ochreous. Antennae fuscous; pectinations in male 2½. Thorax fuscous; patagia yellow. Abdomen fuscous; tuft whitish-ochreous. Legs ochreous-whitish; anterior pair fuscous. Forewings suboval, costa moderately arched, apex rounded, termen slightly rounded, oblique; fuscous with patchy whitish suffusion; a sub-basal fascia from dorsum not reaching costa, pale yellow; this is edged outwardly by a fuscous line from ¼ dorsum, sharply angled inwardly beneath costa, which it reaches at ⅓; immediately beyond is a whitish suffusion crossed by two dentate transverse lines; a subtriangular pale yellow tornal spot; a fuscous fascia from ⅘ costa curved to termen below middle; cilia pale yellow, beneath apex and from below middle to tornus fuscous. Hindwings with termen rounded; grey; cilia grey.

North Queensland: Lake Barrine in June; one specimen.

106. Thallarcha erotis.

Thallarcha erotis Turn. Proc. Lin. Soc. N.S.W., 1914, p. 549.

Queensland: Macpherson Range (3,000 feet). New South Wales: Ebor.

107. Thallarcha isophragma.

Comarchis isophragma Meyr. l.c., p. 739.

Comarchis pallida Luc. Proc. Roy. Soc. Q., 1891, p. 74.

Thallarcha isophragma Hmps. ii., p. 502, Pl. 33, f. 16.

Tasmania: Launceston; St. Helens; Bothwell.

108. Thallarcha epiostola.

Thallarcha epiostola Turn. Proc. Roy. Soc. Tas., 1925, p. 109.

Tasmania: Launceston; Stanley.

109. Thallarcha epileuca.

Thallarcha epileuca Turn. Proc. Roy Soc. Vic., 1922, p. 31.

Queensland: Atherton Plateau; Eungella; Mount Tamborine; Bunya Mountains. New South Wales: Lismore.

110. Thallarcha epicela.

Thallarcha epicela Turn. Proc. Roy. Soc. Vic., 1922, p. 32.

Queensland: Macpherson Range (3,000 feet).

111. *Thallarcha epigypsa.*

Comarchis epigypsa Low. Trans. Roy. Soc. S.A., 1902, p. 212.

Unknown to me.

South Australia: Penola.

112. *Thallarcha fusa.*

Thallarcha fusa Hmps. ii., p. 500, Pl. 33, f. 26.

♂ ♀. 16-26 mm. Head whitish or grey-whitish; face fuscous. Palpi 1; whitish. Antennae fuscous; pectinations in male 1. Thorax dark fuscous; patagia whitish; apices of tegulae and three posterior spots grey. Abdomen ochreous. Legs grey; posterior pair whitish-ochreous. Forewings elongate-triangular, costa gently arched, apex round-pointed, termen gently rounded, oblique; pale grey with fuscous markings; a sub-basal dot and another on base of costa; a line of dots from near base of costa to ¼ dorsum, sharply angled in middle; a narrow median fascia, sometimes divided into two or three parallel dentate lines, its anterior edge sharply indented in middle; a finely dentate interrupted subterminal line; an interrupted terminal line; cilia pale grey. Hindwings with termen gently rounded; pale ochreous or yellow; a large discal spot and small apical patch fuscous.

Queensland: Milmerran; Injune; Carnarvon Ranges. South Australia: Ooldea. West Australia: Perth.

113. *Thallarcha fuscogrisea.*

Thallarcha fuscogrisea Roths. Nov. Zool., 1913, p. 217. Hmps., Suppl. i., p. 787, Pl. 41, f. 10.

Unknown to me.

South Australia: Adelaide.

114. *Thallarcha lechrioleuca* n. sp.

λεχριολευκος, obliquely white.

♂. 18-21 mm. Head white. Palpi 1; fuscous. Antennae fuscous; pectinations in male 1½. Thorax fuscous; patagia and apices of tegulae white. Abdomen ochreous. Legs fuscous; posterior pair pale ochreous. Forewings narrow, scarcely dilated, costa nearly straight, apex rounded, termen obliquely rounded; grey suffused with fuscous; markings white; a basal fascia, outer edge very oblique to mid-dorsum; angled below middle, and containing two or three fuscous dots; an oblique costal patch before apex, anterior edge from ⅝ costa, posterior from ⅘, apex not reaching middle of disc; cilia whitish more or less suffused with fuscous. Hindwings with termen gently rounded; ochreous; a large discal spot and small apical patch fuscous; cilia ochreous.

West Australia: Perth; Rottnest Island; three specimens received from Mr. W. M. Mathews.

115. *Thallarcha rhaptophora.*

Thallarcha rhaptophora Low. Trans. Roy. Soc. S.A., 1915, p. 360.

New South Wales: Broken Hill. South Australia: Mount Lofty.

116. Thallarcha catasticta.

Thallarcha catasticta Low. Trans. Roy. Soc. S.A., 1915, p. 360.

Unknown to me.

New South Wales: Broken Hill. South Australia: Birchip.

117. Thallarcha stramenticolor n. sp.

stramenticolor, straw-coloured.

♂. 26 mm. ♀. 21 mm. Head and thorax pale ochreous. Palpi 1½; pale ochreous. Antennae pale grey; in male with tufts of cilia (1½). Abdomen ochreous-yellow, towards base paler. Legs pale ochreous. Forewings suboval, costa gently arched, apex rounded, termen slightly rounded, oblique; pale ochreous with sparse irroration and very slender transverse lines pale fuscous; first line sub-basal; second from ⅖ costa to mid-dorsum, dentate; third from ⅔ costa to before tornus, dentate, at first outwardly oblique, angled inwards in middle; some pale fuscous terminal dots; cilia pale ochreous. Hindwings with termen slightly rounded; ochreous-yellow with a pale fuscous apical blotch; cilia ochreous.

Queensland: Carnarvon Range in December; two specimens received from Mr. W. B. Barnard, who has the type.

118. Thallarcha sparsana.

Conchylis sparsana Wlk., xxviii., p. 369.

Comarchis sparsana Meyr. l.c., p. 744.

Thallarcha sparsana Hmps. ii., p. 502.

Pallene gracilis Butl. Trans. Ent. Soc., 1877, p. 376.

Queensland: Townsville; Peak Downs; Gayndah; Brisbane; Toowoomba; Warwick; Milmerran; Talwood; Stanthorpe. New South Wales: Murrurundi; Sydney. Victoria: Melbourne.

119. Thallarcha macilenta.

Nudaria macilenta Luc. Proc. Lin. Soc. N.S.W., 1893, p. 137.

Thallarcha macillenta Hmps. (misprint) ii., p. 500, Pl. 33, f. 10.

Antennal pectinations in male 2, in female 1. Forewings white with sparse fuscous irroration; markings dark fuscous; five short oblique equidistant costal streaks; second streak sometimes connected by a fine line with ⅓ dorsum; fourth giving origin to a fine acutely dentate line bent inwards beneath middle and connected with dorsum at ⅔ by a blackish triradiate spot.

Queensland: Brisbane; Toowoomba; Bunya Mountains; Milmerran. New South Wales: Murrurundi; Sydney.

120. Thallarcha leptographa.

Thallarcha leptographa. Turn. Trans. Roy. Soc. S.A., 1899, p. 19. Hmps ii., p. 501, Pl. 33, f. 11.

Queensland: Cairns; Yeppoon; Brisbane; Tweed Heads; Toowoomba. New South Wales: Sydney.

121. Thallarcha trissomochla n. sp.

τρισσομοχλος, three-barred.

♂ ♀. 17-22 mm. Head white or whitish-ochreous. Palpi 1; fuscous. Antennae blackish; pectinations in male 1. Thorax blackish; patagia and apices of tegulae white or whitish-ochreous. Abdomen ochreous-yellow. Legs fuscous; posterior pair ochreous. Forewings elongate, slightly dilated, apex rounded, termen slightly rounded, oblique; white or whitish-ochreous; markings blackish; three narrow transverse fascia; first sub-basal, outwardly curved, with a slight posterior median tooth; second median, inwardly curved from midcosta to ¾ dorsum, with a small median posterior tooth, and another anteriorly above middle; third inwardly curved from ¾ costa to tornus, joined by a short bar to costa before apex, and by another to termen beneath apex; sometimes a fine line on termen beneath this; cilia white or whitish-ochreous, beneath apex fuscous. Hindwings with termen gently rounded; pale ochreous; a discal dot and a small apical patch fuscous; cilia pale ochreous.

Queensland: Townsville in March, May, and July; Toowoomba in August; Stanthorpe in October. New South Wales: Glen Innes in October and April. Ten specimens. North Queensland examples are smaller than those from the south.

122. Thallarcha partita.

Eutane partita Wlk. Undesc. Lep. Het., p. 64.

Eutane tineoides Feld. Reis. Nov. Pl. 106, f. 15.

Eutane amanda Feld. l.c., Pl. 140, f. 36.

Comarchis tineoides Meyr. l.c., p. 741.

Thallarcha partita Hmps. ii., p. 503.

Queensland: Stanthorpe. New South Wales: Glen Innes; Murrurundi. Victoria: ———.

123. Thallarcha oblita.

Pitane oblita Feld. l.c., Pl. 140, f. 23.

Comarchis oblita Meyr. l.c., p. 742.

Thallarcha oblita Hmps. ii., p. 504.

Unknown to me.

New South Wales: Mount Kosciusko (3,000-4,000 feet). Victoria: ———.

124. Thallarcha lochaga.

Comarchis lochaga Meyr. l.c., p. 742.

Thallarcha lochaga Hmps. ii., p. 504, Pl. 33, f. 30.

Queensland: Toowoomba; Stanthorpe. New South Wales: Glen Innes; Sydney.

125. Thallarcha homoschema n.sp.

ὁμοσχημος, of the same pattern.

♂. 22 mm. Head white. Palpi dark fuscous. Antennae fuscous; in male shortly ciliated (½). Thorax dark fuscous; patagia and a

posterior spot white. Abdomen pale ochreous. Legs ochreous; anterior pair fuscous. Forewings elongate-oval, costa moderately arched, apex pointed, termen slightly rounded, oblique; white with fuscous markings; a very narrow basal fascia continued on costa to antemedian fascia; antemedian fascia broad, containing paler costal and dorsal spots, anterior edge from $\frac{1}{5}$ costa to $\frac{1}{3}$ dorsum, concave, posterior edge from $\frac{3}{5}$ costa to $\frac{2}{3}$ dorsum, slightly concave; a moderate subterminal fascia from $\frac{3}{4}$ costa to tornus, angled inwards in middle; a broad terminal line interrupted above and below middle; cilia fuscous. Hindwings with termen rounded; pale ochreous; cilia pale ochreous.

Queensland: Macpherson Range (3,000 feet) in March; one specimen received from Mr. W. B. Barnard, who has the type.

126. *Thallarcha mochlina.*

Comarchis mochlina Turn. Trans. Roy. Soc. S.A., 1899, p. 20.

Thallarcha mochlina Hmps. ii., p. 505, Pl. 33, f. 18.

Queensland: Brisbane.

127. *Thallarcha chrysochoa.*

Comarchis chrysochoa Meyr. l.c., p. 740.

Antennae of male with very short pectinations. In *T. jocularis* these are absent, only tufts of cilia being developed.

New South Wales: Mount Kosciusko (3,500-4,500 feet). Victoria: Gisborne.

128. *Thallarcha jocularis.*

Mosoda jocularis Rosen. Ann. Mag. Nat. Hist, (5), xvi., p. 381, Pl. 11, f. 6.

Thallarcha jocularis Hmps. ii., p. 503.

Comarchis jocularis Meyr. l.c., p. 741.

New South Wales: Armidale; Ebor; Murrurundi; Sydney; Moruya; Bathurst. Victoria: Beaconsfield; Moe. Tasmania: Waratah; Cradle Mountain; Derwent Bridge; Hobart.

129. *Thallarcha staurocola.*

Comarchis staurocola Meyr. l.c., p. 743.

Thallarcha staurocola Hmps. ii., p. 504, Pl. 33, f. 14.

Queensland: Brisbane; Rosewood; Toowoomba; Dalby; Killarney; Stanthorpe. New South Wales: Lismore; Newcastle; Sydney.

45. Gen. XANTHODULE.

Butl. Trans. Ent. Soc, 1886, p. 384. Hmps. ii., p. 340.

Tongue absent. Palpi minute. Antennae in male bipectinate to apex. Posterior tibiae with middle spurs. Forewings with 2 from beyond middle, 3, 4, 5 separate, 6, 7, 8 stalked, 9 absent, 10 from end of cell, 11 from near end, free. Hindwings with cell long; 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 separate, 6 and 7 stalked, 12 anastomosing with cell to beyond middle. Female apterous. Type, *X. semiochrea.* Only two species are known.

130. Xanthodule semiochrea.

Xanthodule semiochrea Butl. Trans. Ent. Soc., 1886, p. 384, Pl. 9, f. 1. Hmps. ii., p. 341.

Anestia inquinata Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1083.

♀. Apterous; larva on lichens.

Queensland: Peak Downs; Gayndah; Brisbane; Rosewood; Toowoomba; Chinchilla; Miles; Stanthorpe. New South Wales: Murrurundi; Scone.

131. Xanthodule ombrophanes.

Anestia ombrophanes Meyr. l.c., p. 746.

Xanthodule ombrophanes Hmps. ii., p. 340, Pl. 28, f. 4.

Victoria: Melbourne; Gisborne. West Australia: Perth; Merredin.

46. Gen. THUMATHA.

Wlk. xxxv., p. 1900. Hmps ii., p. 420.

Tongue absent. Palpi short, porrect, smooth, acute. Antennae of male bipectinate to apex. Posterior tibiae with middle spurs. Forewings with 2 from near middle, 3, 4, 5 separate, 6, 7, 8 stalked, 9 absent, 10 from before end of cell, 11 from middle running into 12. Hindwings with cell long; 2 from $\frac{4}{5}$, 3 and 4 connate or stalked, 5 approximated to 4 at origin, 6 and 7 stalked, 12 anastomosing to near end of cell. Type, *T. fuscescens* Wlk. A second species is recorded from Africa.

132. Thumatha fuscescens.

Thumatha fuscescens Wlk., xxv., p. 1901. Hmps. ii, p. 421.

Nudaria infantula Saalm. Ber. Schenk. Ges., 1879, p. 261.

Scaeodora rava Luc. Proc. Lin. Soc. N.S.W,. 1889, p. 1079.

Queensland: Ingham; Brisbane; Tweed Heads. Also from Borneo, Ceylon, India, and Africa.

47. Gen. IONTHAS.

Hmps., Suppl. i., p. 777. Turn. Proc. Roy. Soc. Q., 1915, p. 19.

Tongue absent. Palpi minute, porrect. Antennae of male bipectinate to apex. Posterior tibiae with spurs normal. Forewings with 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 from below upper angle, 7 and 8 stalked, 9 absent, 10 from end of cell, 11 from $\frac{3}{4}$, free. Hindwings with 2 from $\frac{3}{4}$, 3 and 4 closely approximated or connate, 5 approximated, 6 and 7 stalked, 12 anastomosing to middle of cell. Female unknown, probably apterous. Monotypical. Allied to *Poliodule*.

133. Ionthas ataracta.

Ionthas ataracta Hmps., Suppl. i., p. 777. Turn. Proc. Roy. Soc. Q., 1915, p. 20.

The forewings may be wholly pale fuscous, or may have a pale yellow median costal blotch more or less developed.

Queensland: Warwick; Milmerran; Dalby; Injune; Stanthorpe.

48. Gen. ASURA.

Wlk. ii., p. 484. Meyr. l.c., p. 747. Hmps. ii., p. 426.

Tongue present. Palpi moderate or short, porrect, acute. Antennae of male bipectinate to apex; of female shortly bipectinate, serrate, or simple. Posterior tibiae often with middle spurs, but these may be minute or absent, terminal spurs often short. Forewings with 2 from middle to $\frac{2}{3}$, 3, 4, 5 widely separate, 6 from beneath upper angle, 7, 8, 9 stalked, 7 separating before 9, 10 from near end of cell, 11 from towards end, anastomosing with 12 at a point or for some distance. Hindwings with 2 from near middle to $\frac{2}{3}$, 3, 4, and 5 separate, 6 and 7 stalked, 12 anastomosing with cell to $\frac{2}{3}$ or to near end. Type, *A. cervicalis.* A natural genus but with some variations in structural details. These will be mentioned in dealing with the species. It is confined to the Indio-malayan region and is most developed in New Guinea.

Key to Species.

1.	Hindwings with termen straight or slightly sinuate	2	
	Hindwings with termen rounded	7	
2.	Forewings with antemedian transverse line ..	3	
	Forewings without antemedian line		*crocopepla*
3.	Hindwings blackish with orange spots	4	
	Hindwings not blackish except on margins ..	5	
4.	Hindwings with two orange spots		*zebrina*
	Hindwings with one orange spot		*monospila*
5.	Abdomen blackish	6	
	Abdomen orange		*catameces*
6.	Hindwings with dorsum red		*coccinocosma*
	Hindwings with dorsum blackish		*semivitrea*
7.	Forewings orange with fuscous transverse fasciae		*crocoptera*
	Forewings fuscous with orange or yellow markings	8	
8.	Forewings with antemedian line (sometimes interrupted)	9	
	Forewings without antemedian line	10	
9.	Thorax orange		*polyspila*
	Thorax blackish		*lydia*
10.	Hindwings orange almost to base		*compsodes*
	Hindwings with basal third fuscous	11	
11.	Thorax with orange posterior spot		*bipars*
	Thorax without posterior spot	12	
12.	Posterior tibiae with middle spurs absent ..		*habrotis*
	Posterior tibiae with middle spurs short or minute		*cervicalis*

134. *Asura coccinocosma* n.sp.

κοκκινοκοσμος, decorated with red.

♂. 24-26 mm. Head red, between antennae blackish. Palpi short (1); blackish. Antennae blackish; pectinations in male 6. Thorax blackish; bases of tegulae and two median spots red. Abdomen blackish. Legs blackish; tarsi except apices pale ochreous; posterior tibiae with spurs normal. Forewings narrow, posteriorly dilated, costa almost straight, apex rounded, termen long, very oblique; anastomosis between 11 and 12 long; blackish with red lines and spots; sub-basal and antemedian lines sometimes partly confluent; a large median dorsal spot some times connected with a small spot on $\frac{1}{3}$ costa; a transversely elongate spot in middle of disc; a spot on $\frac{2}{3}$ costa giving off an interrupted

line to tornus; two subterminal spots, of which one or both may be obsolete; cilia blackish. Hindwings with termen sinuate; hyaline and translucent except on margins; apex and termen blackish; costa and dorsum red; cilia blackish, on dorsum red.

♀. 26-27 mm. Forewings broader and with an additional subapical spot. Hindwings with termen straight; red with blackish apical spot and terminal line. The female resembles *A. polyspila*, but in that species a band replaces the terminal line.

North Queensland: Cape York in April; eleven specimens received from Mr. W. B. Barnard, who has the type.

135. *Asura semivitrea.*

Eutane semivitrea Roths. Nov. Zool., 1913, p. 216.

Asura semivitrea Hmps., Suppl. i., p. 745, Pl. 38, f. 35.

♂. 25 mm. Head orange, blackish between antennae; face yellow. Palpi short (1); blackish. Antennae blackish; ciliations in male 6. Thorax and abdomen blackish; apex of tuft whitish-ochreous. Legs blackish; posterior tarsi with whitish-ochreous median band. Forewings narrow, posteriorily dilated, costa almost straight, apex rounded, termen obliquely rounded; blackish with orange spots and lines; adjacent subbasal and antemedian lines; a small oblique subdorsal spot before middle; a large transversely elongate median spot; a small spot beneath $\frac{3}{5}$ costa, from beneath which a slender line runs to tornus; a subapical dot and two subterminal spots; cilia blackish. Hindwings with termen slightly sinuate; central part hyaline and translucent; a large apical blotch and terminal line with a short tornal process blackish, edged anteriorly with orange; cilia blackish.

Queensland: Mackay; Yeppoon; in October.

136. *Asura crocopepla* n.sp.

κροκοπεπλος, in saffron robe.

♂ ♀. 26-29 mm. Head and thorax orange. Palpi moderate ($1\frac{1}{2}$); ochreous. Antennae blackish; ciliations in male 4. Abdomen orange; tuft in male blackish. Legs blackish; posterior tarsi beneath and sometimes above pale ochreous except at apex; posterior tibiae without middle spurs, terminal spurs short. Forewings narrow, posteriorly dilated, costa straight to $\frac{3}{4}$, thence slightly arched, apex rounded, termen obliquely rounded; 11 anastomosing at a point with 12; blackish with orange spots; a large basal spot separated by a blackish line from a quadrangular dorsal spot, which reaches middle; an elongate subcostal spot separated from the preceding by a longitudinal blackish line; a small triangular spot above base of vein 2 and dots above and below this vein near dorsum; sometimes a third dot above these; a round subapical spot; cilia blackish. Hindwings alike in both sexes; termen sinuate, apex rounded; orange; a small apical blotch and a line on termen and dorsum blackish; cilia blackish.

North Queensland: Cape York in April; ten specimens received from Mr. W. B. Barnard, who has the type.

137. *Asura catameces* n.sp.

καταμηκης, very long.

♂. 25-28 mm. Head orange, between antennae blackish. Palpi short (1); blackish. Antennae blackish; pectinations in male 1½. Thorax blackish; bases of tergulae and a pair of longitudinal lateral marks orange. Abdomen orange; apices of segments, sides towards apex, and a postmedian band beneath blackish. Legs blackish; posterior tarsi with a median ochreous band; posterior tibiae with two pairs of short spurs. Forewings narrow, posteriorly dilated, costa gently arched, apex rounded, termen obliquely rounded; blackish with orange-yellow spots; a sub-basal spot; a transverse line from beneath ⅕ costa to ¼ dorsum; a broad transversely elongate spot before middle; a median spot of variable size; a short oblique mark from ⅗ costa approaching a line, which runs obliquely inwards to ¾ dorsum; large tornal and subapical spots; cilia blackish. Hindwings with termen nearly straight; orange; a broad fuscous terminal band, broader at apex; cilia fuscous.

North Australia: Darwin in January (F. P. Dodd); Batchelor (G. F. Hill); Three specimens.

138. *Asura zebrina.*

Hmps., Suppl. i., p. 739, Pl. 38, f. 26. Turn. Proc. Roy Soc. Q., 1915, p. 19.

Posterior tibiae with two pairs of short spurs. Forewings with long anastomosis between 11 and 12. Antennae of female not pectinate.

Queensland: Yeppoon; Macpherson Range. New South Wales: Lismore; Bulli.

139. *Asura monospila* n.sp.

μονοσπιλος, one-spotted.

♀. 25 mm. Head orange. Palpi 1; ochreous. Antennae blackish; in female not pectinate. Thorax blackish; patagia and basal spots on tegulae orange. Abdomen blackish. Legs dark fuscous; middle and posterior tarsi except apices ochreous. Forewings strongly dilated posteriorly, costa straight to ⅔, thence arched, apex pointed, termen long, rounded, oblique; 11 anastomosing with 12 for some distance; blackish; a sub-basal orange bar not reaching costa or dorsum; cilia blackish. Hindwings with termen straight; blackish; an elongate orange spot on base of costa; cilia blackish.

Queensland: Cairns in February; one specimen received from Mr. Geo. Lyell, who has the type.

140. *Asura crocoptera* n.sp.

κροκοπτερος, saffron-winged.

♂. 25 mm. Head, thorax, and abdomen orange-ochreous. Antennae dark fuscous, base of stalk ochreous; in male bipectinate to apex, pectinations 5 Legs ochreous. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen long, obliquely rounded; orange-ochreous marked with fuscous; two transverse fasciae broadly connected by a median bar; first from ⅓ costa to ⅓ dorsum, with an obtuse anterior median tooth; second from ⅘ costa to before ⅘ dorsum,

with an acute posterior tooth; a narrow terminal band; cilia orange-ochreous. Hindwings with apex and termen rounded, 3, 4, 5 somewhat approximated; orange-ochreous; dorsal edge and a narrow terminal band fuscous; cilia ochreous.

Queensland: Toowoomba in November; one specimen received from Mr. W. B. Barnard, who has the type.

141. *Asura polyspila* n.sp.

πολυσπιλος, many-spotted.

♂ ♀. 20-27 mm. Head orange. Palpi very short (½); ochreous. Antennae blackish; pectinations in male 4 Thorax orange; apices of tegulae and a posterior spot dark fuscous. Abdomen dark fuscous; tuft in male pale ochreous. Legs fuscous; tarsi except apices pale ochreous; posterior tibiae with spurs short. Forewings elongate-oval. costa moderately arched, apex pointed, termen obliquely rounded; anastomosis of 11 and 12 long; dark fuscous with orange spots; a sub-basal fascia not reaching costa; a transverse line from ⅕ costa to ¼ dorsum; an antermedian dorsal spot sometimes connected with a smaller spot on ⅓ costa; a transversely elongate median spot; a line from ⅗ costa to before tornus; three subterminal spots, the apical one sometimes obsolete; cilia fuscous. Hindwings with termen gently rounded; orange with a terminal fuscous band broader at apex; cilia fuscous.

North Queensland: Cape York in April (Barnard); Kuranda in October, November, January, and April; six specimens received from Mr. F. P. Dodd.

142. *Asura lydia.*

Bombyx lydia Don. Ins. N. Holl, Pl. 40, f. 3.

Asura lydia Meyr. l.c., p. 747. Hmps. ii., p. 426.

Dysauxes mediastina Hb. Zutr. Ex. Schmet., iii., p. 37, f. 505, 506.

Asura gaudens Wlk., ii., p. 485.

Setina pectinata Wlgrn., Wien. Ent. Mon., iv., p. 46.

Posterior tibiae with spurs normal. Forewings with anastomosis of 11 and 12 long.

Queensland: Gympie; Nambour; Brisbane; Stradbroke Island; Tweed Heads; Bunya Mountains; Milmerran. New South Wales: Lismore; Tabulam; Grafton; Glen Innes; Armidale; Ebor; Scone; Newcastle; Sydney; Wollongong; Jervis Bay. Victoria: Melbourne; Fernshaw; Gisborne; Dunkeld. Tasmania: Launceston.

143. *Asura bipars.*

Stonia bipars Wlk., xxxi., p. 187.

Asura bipars Hmps. ii., p. 427, Pl. x 30, f. 1.

Posterior tibiae without middle spurs. Forewings with 11 and 12 anastomosing at a point.

Queensland: Cairns; Townsville; Rockhampton; Yeppoon; Eidsvold; Brisbane; Stradbroke Island; Tweed Heads. New South Wales: Sydney.

144. Asura habrotis.

Asura habrotis Meyr. l.c., p. 748. Hmps., Suppl. i., p. 746, Pl. 39, f. 1.

Posterior tibiae without middle spurs. Forewings with 11 anastomosing with 12 at a point or for a short distance

Queensland: Cairns; Townsville; Rockhampton; Yeppoon; Eidsvold; Brisbane; Stradbroke Island; Tweed Heads: New South Wales: Sydney. Tasmania: Launceston.

145. Asura compsodes n.sp.

κομψώδης, elegant.

♂ 22-25 mm. Head dark fuscous; face yellow. Palpi short; fuscous. Antennae dark fuscous; ciliations in male 6. Thorax dark fuscous; patagia orange-yellow. Abdomen dark fuscous with broad dorsal and narrow lateral yellow stripes. Legs fuscous; posterior tibiae without middle spurs, terminal spurs very short. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence arched, apex rounded, termen obliquely rounded; 11 anastomosing with 12 at a point; dark fuscous with orange-yellow dots; a median dot at $\frac{1}{5}$; a dot at end of cell at $\frac{3}{4}$ and two small dots above tornus; cilia dark fuscous. Hindwings with termen and apex rounded; dark fuscous; a large roundish orange-yellow spot nearer dorsum than costa, reaching from near base almost to tornus; cilia dark fuscous.

Queensland: Toowoomba in November; Bunya Mountains in December and January; four specimens.

146. Asura cervicalis.

Wlk ii., p. 484. Meyr. l.c., p. 748. Hmps. ii., p. 427, Pl. 30, f. 23.

Posterior tibiae with middle spurs short or minute. Forewings with 11 and 12 anastomosing or connected at a point.

It is difficult to distinguish this species from *A habrotis* in some cases. The following points are helpful:—(1) In *cervicalis* the middle tibiae are short or minute, in *habrotis* absent. There may be exceptions to this, but I have not met with any. (2) In *cervicalis* the sexes are of nearly equal size; in *habrotis* the females are considerably smaller than the males. (3) The males of *cervicalis* are usually larger than those of *habrotis*, the forewings proportionally broader and with more rounded apices

Queensland: Yeppoon; Eidsvold; Brisbane; Stradbroke Island; Tweed Heads; Bunya Mountains. New South Wales: Lismore; Tenterfield; Gosford; Sydney; Jervis Bay. Victoria: Melbourne; Gisborne; Myrtleford. Tasmania: Launceston; Swansea; Ross; Georgetown.

49. Gen. HABROCHROMA nov.

ἁβροχρωμος, soft.

Tongue present. Palpi very short, slender, smooth, porrect, acute. Antennae of male with cilia and bristles. Posterior tibiae with two pairs of normal spurs. Forewings with 2 from near middle, 3 and 4 coincident from angle and 5 remote in male, 3 from well before angle and 4 and 5 separate in female, 6 from well below upper angle, 7, 8, 9 stalked, 7 separating before 9, 10 from end of cell, 11 from $\frac{3}{4}$ running

into or anastomosing with 12. Hindwings with 2 from $\frac{2}{3}$ or near middle, 3, 4, 5 separate, 6 and 7 stalked, 12 anastomosing to end of cell.

Differs from *Asura* in the absence of vein 3 in forewings of male and in the non-pectinate antennae.

147. *Habrochroma ectophaea.*

Asura ectophaea Hmps. ii., p. 451, Pl. 1, 31, f. 9.

Asura atrifusa Hmps. ii., p. 464, Pl. 31, f. 26.

♂ ♀. 23-28 mm. Head and thorax ochreous-yellow. Palpi $\frac{3}{4}$; grey. Antennae pale grey; ciliations in male 1, bristles 3. Abdomen pale ochreous-yellow; tuft in male fuscous. Legs fuscous; posterior pair pale ochreous. Forewings suboval, costa gently arched, apex rounded, termen rounded, oblique; ochreous-yellow, sometimes suffused with fuscous except on margins; often without markings, but the following fuscous transverse lines may be partly or wholly developed; a curved line from $\frac{1}{4}$ costa to $\frac{1}{4}$ dorsum a suffusedly dentate line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum; an irregular suffused subterminal line; cilia ochreous-yellow. Hindwings with termen rounded; pale ochreous-yellow, often more or less suffused with fuscous especially towards termen; cilia pale ochreous-yellow.

North Australia: Darwin. Queensland: Mossman in June; Cairns; Kuranda in January, April, and May; Atherton Plateau in September and June; Brisbane in January and March; Tweed Heads in April; Macpherson Range in February. New South Wales: Lismore in April,

50. Gen. PALLENE.

Pallene Wlk., ii., p. 542.

Tongue present. Palpi short or moderate, porrect. Antennae in male with cilia and bristles, rarely pectinate. Posterior tibiae with spurs usually short; middle spurs rarely minute or absent. Forewings with 2 from middle, 3, 4, 5 separate, 6 from near upper angle, 7, 8, 9 stalked, 7 separating before 9, 10 from well before end of cell, 11 from $\frac{3}{4}$, anastomosing with 12 at a point or for some distance. Hindwings with 2 from $\frac{3}{4}$, 3 separate, 4 and 5 stalked, or rarely approximated, 6 and 7 stalked, 12 anastomosing to near end of cell. Type, *P. structa.* A large genus well represented in the Indo-malayan region with several species in Africa.

Differe from *Asura* either in the stalking or at least approximation of 4 and 5 of hindwings, or in the non-pectinated antennae of the male.

KEY TO SPECIES.

1. Forewings pale yellow or whitish-ochreous ..	2	
Forewings not pale yellow or whitish-ochreous ..	4	
2. Forewings with median transverse line	3	
Forewings without median line		*prionosticha*
3. Forewings whitish-ochreous, subterminal line not connected by streaks with termen, male antennae not pectinate		*saginaea*
Forewings pale yellow, subterminal connected by two streaks with termen, male antennae pectinate		*homoea*
4. Hindwings without markings	5	
Hindwings not without markings	7	

5. Forewings with circular discal spot	6	
Forewings without discal spot		*pyraula*
6. Forewings crimson-spotted		*reticulata*
Forewings with pale reddish spots only		*quadrilineata*
7. Hindwings with fuscous terminal band		*structa*
Hindwings with subterminal line only		*serratilinea*

148. *Pallene saginaea.*

Calligenia saginaea Turn. Trans. Roy. Soc. S.A., 1899, p. 11.

Gymnasura saginaea Hmps. ii., p. 425.

Calligenia limonis Luc. Proc. Roy. Soc. Q., 1899, p. 139.

Lyclene eldola Swin. Ann. Mag. Nat. Hist. (7), vii., p. 468.

Asura eldola Hmps., Suppl. i., p. 768, Pl. 40, f. 12.

Miltochrista flavida Butl Ann. Mag. Nat. Hist. (5), xix., p. 219.

Asura flavia Hmps. ii., p. 429, Pl. 30, f. 7.

Posterior tibiae with middle spurs minute or absent. Hindwings with 5 approximated at origin to 4.

North Australia: Adelaide River. Queensland: Cooktown; Cairns; Herberton; Duaringa.

149. *Pallene homoea* n.sp.

ὅμοιος, similar.

♂. 18-20 mm. Head pale yellow. Palpi fuscous. Antennae pale yellow; in male bipectinate to apex, pectinations 4. Thorax pale yellow; bases of tegulae and a central dot fuscous. Abdomen whitish-ochreous. Legs pale ochreous; anterior pair and apex of middle tibiae fuscous; posterior tibiae without middle spurs. Forewings suboval, costa moderately arched, apex rounded, termen obliquely rounded; pale yellow with fuscous markings; a basal dot, sometimes connected with sub-basal line by costal and median streaks; sub-basal line incurved, median from before mid-costa to beyond mid-dorsum, wavy, connected with sub-basal by one or two fine streaks in disc; a finely rippled postmedian line from ¾ costa, almost touching median on dorsum; a rippled subterminal line connected with termen by two streaks in disc; cilia pale yellow. Hindwings with termen gently rounded; whitish-ochreous; an apical fuscous spot with a smaller spot beneath; cilia whitish-ochreous.

Very like *P. saginaea*, but clearly distinguished by the pectinated antennae of male.

North Queensland: Cape York in April and June; two specimens received from Mr. W. B. Barnard, who has the type.

150. *Pallene prionosticha* n.sp.

πριονοστιχος, with serrate lines.

♀. 21-23 mm. Head, palpi, and antennae pale yellow. Thorax pale yellow; a streak on tegulae and two anterior and one posterior spots fuscous. Abdomen whitish-ochreous. Legs whitish-ochreous; anterior pair and apices of middle tibiae fuscous; posterior tibiae with middle spurs well developed or minute. Forewings suboval costa moderately arched, apex rounded, termen obliquely rounded; pale yellow with fuscous markings; a basal dot sometimes connected with

sub-basal line by a streak in disc; sub-basal acutely dentate, from $\frac{1}{4}$ costa to $\frac{1}{4}$ dorsum; postmedian irregularly dentate from middle of costa, with a rounded posterior projection, thence inwardly oblique to mid-dorsum; subterminal acutely dentate, connected by two streaks with termen; cilia pale yellow. Hindwings with termen gently rounded; whitish-ochreous; cilia whitish-ochreous.

Differs from the two preceding species by the absence of a median transverse line on forewings.

North Queensland: Cape York in October and May; two specimens received from Mr. W. B. Barnard, who has the type.

151. *Pallene pyraula.*

Calligenia pyraula Meyr. l.c., p. 704.

Asura pyraula Hmps. ii., p. 443, Pl. 30, f. 10. Suppl. i., p. 752.

Forewings of male with a tuft of long hairs from near base of dorsum beneath; hindwings with a subcostal strip of androconia above.

North Queensland: Cairns; Lake Barrine. Also from New Guinea.

152. *Pallene reticulata.*

Cyme reticulata Feld. Sitz. Akad. Wien., vii., p. 36.

Barsine placens Wlk., xxxi., p. 251.

Calligenia cyclota Meyr. l.c., p. 705.

Barsine intrita Swin. Cat. Oxf. Mus. i., p. 108, Pl. 3, f. 23.

Asura reticulata Hmps. ii., p. 442.

Posterior tibiae without middle spurs.

North Queensland: Cairns; Mount Mulligan; Innisfail. Also from New Guinea and the Moluccas.

153. *Pallene quadrilineata.*

Calligenia quadrilineata Pag. Jahr. Nass. Ver., xxxix., p. 126 (Aug., 1886).

Calligenia melitaula Meyr. l.c., p. 705 (Nov., 1886).

Miltochrista simulans Butl. Trans. Ent. Soc., 1886, p. 382 (Dec.).

Asura quadrilineata Hmps. ii., p. 444, Pl. 30, f. 16.

Posterior tibiae with two pairs of short spurs. Forewings with 11 and 12 shortly anastomosing, connected, or sometimes only approximated.

North Australia: Darwin; Stapleton; Brock's Creek. Queensland: Cairns; Innisfail; Atherton Plateau; Ingham; Ayr; Bowen; Proserpine; Rockhampton. Also from Aru Island.

154. *Pallene structa.*

Pallene structa Wlk. ii., p. 543.

Asura structa Hmps. i., p. 446, Pl. 30, f. 20.

Calligenia structa Meyr. l.c., p. 706.

Prinasura pyrrhopsamma Hmps., Suppl. i., p. 743.

Posterior tibiae with spurs normal.

Queensland: Nambour; Brisbane; Stradbroke Island; Tweed Heads. New South Wales: Lismore; Ballina; Newcastle; Gosford; Sydney; Jervis Bay.

155. *Pallene serratilinea* n.sp.

serratilineus, with serrate lines.

♂ ♀. 24-28 mm. Head reddish-orange. Palpi 2; fuscous. Antennae fuscous; bipectinate in both sexes, pectinations in male 1½; in female ¾, each with a long terminal bristle. Thorax reddish-ochreous with a posterior fuscous spot. Abdomen pale ochreous. Legs fuscous; posterior pair pale ochreous; posterior tibiae with spurs normal. Forewings broadly triangular, costa strongly rounded, termen rounded, oblique; reddish-ochreous with fuscous lines and dots; a basal fascia not reaching dorsum; antemedian, median, and postmedian transverse lines, outwardly curved and strongly serrated; median area sometimes fuscous-suffused; a subterminal series of dots closely following; cilia reddish-ochreous barred with fuscous. Hindwings with termen strongly rounded; pale ochreous; a fine dentate fuscous subterminal line; cilia pale ochreous with some fuscous bars.

North Queensland: Ravenshoe and Millaa Millaa in September November, December, and January; six specimens.

51. Gen. STENARCHA.

Hmps. ii. p. 264.

Tongue present. Palpi moderate, ascending, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from near angle, 3 and 4 coincident and stalked with 5, 6 from below upper angle, 7, 8, 10 stalked, 9 absent 11 from end of cell, free. Hindwings with 2 from near angle, 3 and 4 long-stalked or coincident, 5 approximated to 4, 6 and 7 stalked, 12 anastomosing with cell to middle. Monotypical.

The neuration differs from that given by Hampson in the absence of vein 4 in one or both wings. Further material may show that both variations occur in the forewings.

156. *Stenarcha stenopa.*

Chiriphe stenopa Meyr. l.c., p. 732.

Stenarcha stenopa Hmps. ii., p. 265.

West Australia: Albany; Mundaring, near Perth.

52. Gen. PSEUDOPHANES.

χευδοφανης, deceitful.

Tongue well developed. Palpi very short, porrect or ascending. Antennae in male with cilia and bristles. Posterior tibiae with two pairs of very short spurs. Forewings with 2 from ⅗, 3 from before angle, 4, 5 separate, 6, 7, 8 stalked, 9 absent, 10 from end of cell, 11 from towards

end, free. Hindwings with 2 from towards angle, 3 and 4 stalked 5 remote from below middle, 6 and 7 long-stalked, 12 anastomosing to middle of cell. Monotypical. A development from *Asura*. The type species is an almost perfect mimic of a black *Syntomis*.

157. Pseudophanes melanoptera n.sp.

μελανοπτερος, black-winged.

♂ ♀. 34-40 mm. Head orange, blackish between antennae. Palpi 1; blackish. Antennae blackish; ciliations in male ½, bristles ¾. Thorax blackish; patagia, bases of tegulae, and a large posterior spot orange. Abdomen blackish with orange rings; tuft in male blackish. Legs blackish. Forewings elongate, posteriorly dilated, costa straight to ⅔, thence arched, apex rounded, termen slightly rounded, extremely oblique; blackish; cilia blackish. Hindwings with termen sinuate; blackish; cilia blackish.

North Queensland: Kuranda in September and October; seven specimens received from Mr. F. P. Dodd.

53. Gen. PANACHRANTA.

Turn. Proc. Roy. Soc. Vic., 1922, p. 20.

Tongue weakly developed. Palpi short, porrect; second joint rough beneath; terminal joint very short, acute. Antennae in male with short ciliations and longer bristles. Posterior tibiae with two pairs of short spurs. Forewings with 2 from middle, 3 from before angle, 4 and 5 separate, 6, 7, 8 stalked, 9 absent, 10 from well before end of cell, 11 approximated at origin to 10, free. Hindwings with 2 from ⅔, 3 and 4 stalked, 5 remote and from middle of cell in male, approximated to or connate with 4 in female, 6 and 7 stalked, 11 anastomosing to middle of cell. Monotypical.

158. Panachranta lirioleuca.

Panachranta lirioleuca Turn. Proc. Roy. Soc. Vic., 1922, p. 20.

North Queensland: Kuranda.

54. Gen. MELASTROTA.

Hmps. Ann. Mag. Nat. Hist. (7), xv., p. 439. Suppl. i., p. 806.

Tongue well developed. Palpi short, porrect, loose-haired, acute. Antennae in male minutely ciliated towards apex. Posterior tibiae with middle spurs. Forewings with 2, 3, 4 approximated from angle, 5 absent, 6 from below upper angle, 7 and 8 stalked from end of cell, 9 and 10 stalked from well before end of cell, 11 from middle anastomosing at a point with 12, two veinlets from 12 to costa. Hindwings with 2 from middle, 3 and 4 coincident, 5 absent, 6 and 7 stalked. 12 anastomosing to middle of cell. Monotypical.

159. Melastrota nigrisquamata.

Pseudoblades nigrisquamata Swin. Ann. Mag. Nat. Hist. (7), vii., p. 467. ♂.

Melastrota nigrisquamata Hmps., Suppl. i., p. 807.

Pseudoblades dona Swin. l.c., 467. ♀.

Melastrota dona Hmps. l.c., p. 807, Pl. 41, f. 34.

♂. 18-20 mm. Head, palpi, antennae, and thorax pale yellow. Abdomen and legs pale ochreous. Forewings suboval, costa rather strongly arched, apex rounded, termen obliquely rounded; pale ochreous-brown; a small pale yellow suffusion at apex; sometimes a brown dot on $\frac{2}{3}$ dorsum; cilia yellow, on tornus pale ochreous-brown. Hindwings with a costal expansion; termen rounded; very pale ochreous, towards apex grey; cilia pale ochreous. Underside of forewings with a patch of blackish androconia from near base to $\frac{2}{3}$ on costal side of cell.

♀. 20-22 mm. Forewings fuscous-brown with yellow markings; a narrow basal fascia; a triangular spot on midcosta; a marginal streak from $\frac{3}{4}$ costa around apex, not reaching tornus; cilia yellow, on tornus fuscous-brown. Hindwings grey, basal area pale ochreous.

North Queensland: Mossman; Cairns; 11 males, 3 females .

55. Gen. NESOTROPHA.

Turn. Proc. Roy. Soc. Tas., 1925, p. 110.

Tongue absent. Palpi short, porrect; second joint rough-scaled beneath; terminal joint slender, acute. Antennae of male pectinated to apex. Posterior tibiae with two pairs of long spurs. Forewings with 2 from near angle, 3, 4, 5 approximated, 6 from well below upper angle, 7 separate, 8, 9 10 stalked, 11 from $\frac{2}{3}$, free. Hindwings with 2 from near angle, 3 and 4 approximated, 5 from middle, 6 separate, approximated to 5, widely separate from 7, 12 anastomosing with cell to $\frac{1}{3}$. Monotypical. An isolated genus perhaps allied to *Poliodule*.

160. Nesotropha pymaeodes.

Nesotropha pymaeodes Turn. Proc. Roy Soc. Tas., 1925, p. 110.

Tasmania: Cradle Mountain (3,000 feet).

56. Gen. PHILENORA.

Philenora Rosen. Ann. Mag. Nat. Hist. (5), xvi., p. 382. Hmps. ii., p. 506.

Tongue present. Palpi short, ascending; second joint thickened with appressed scales; terminal joint acute. Antennae in male shortly ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 widely separate, 6 from well below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from towards end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 widely separated, 6 and 7 stalked, 12 anastomosing to near end of cell. Type, *P. undulosa*. *Scaeodora* Meyr. is a synonym. So far as known the genus is confined to Australia and Madagascar, a curious distribution, which is not easy to explain.

KEY TO SPECIES.

1. Hindwings yellow	2	
Hindwings not yellow	5	
2. Hindwings with a dark fuscous terminal band ..		*placochrysa*
Hindwings with fuscous apical blotch not reaching midtermen	3	

3. Forewings with discal dot	4	
Forewings without discal dot		*aspectatella*
4. Forewings with median fascia narrow and angled outwards in middle		*undulosa*
Forewings with median fascia broad and not angled		*elegans*
5. Forewings white or whitish	6	
Forewings not so	7	
6. Forewings with a basal fuscous patch		*thelxinoa*
Forewings without basal patch		*nudaridia*
7. Forewings brownish-fuscous		*omophanes*
Forewings not brownish-fuscous	8	
8. Forewings with transverse lines	9	
Forewings without transverse lines		*cataplex*
9. Forewings with oblique white terminal line ..		*chionastis*
Forewings without white terminal line		*pteridopola*

161. Philenora placochrysa.

Scaeodora placochrysa Turn. Trans. Roy. Soc. S.A., 1899, p. 18. Hmps. ii., p. 511, Pl. 33, f. 27.

North Queensland: Cairns.

162. Philenora aspectatella.

Oecophora aspectatella Wlk., xxix., p. 679.

Comarchis aspectatella Meyr. l.c., p. 745.

Philenora aspectatella Hmps. ii., p. 509.

Tinea oecophorella Wlk., xxxv., p. 1813.

Comarchis irregularis Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1082.

Queensland: Mackay; Gayndah; Caloundra; Brisbane; Esk; Macpherson Range (3,500 feet); Toowoomba; Warwick; Stanthorpe. New South Wales: Ebor; Sydney; Jervis Bay; Mount Kosciusko (4,000 feet). Victoria: Melbourne; Moe.

163. Philenora elegans.

Pallene elegans Butl. Trans. Ent. Soc., 1877, p. 334.

Philenora elegans Hmps. ii., p. 510, Pl. 33, f. 19.

Comarchis lunata Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1083.

Queensland: Brisbane; Stradbroke Island; Macpherson Range (3,500 feet); Toowoomba. New South Wales: Murrurundi; Sydney. West Australia: Yanchep; Busselton.

164. Philenora undulosa.

Acontia undulosa Wlk., xii., p. 797.

Philenora undulosa Hmps. ii., p. 510, Pl. 33, f. 25.

Termessa lyelliana Low. Trans. Roy. Soc. S.A., 1893, p. 148.

New South Wales: Guyra; Ebor. Victoria: Melbourne; Gisborne. Tasmania: ——.

165. Philenora nudaridia.

Philenora nudaridia Hmps. ii., p. 511, Pl. 33, f. 4.

Unknown to me.

North Queensland: Cairns.

166. Philenora thelxinoa n.sp.

θελξινοος, charming.

♂. 18 mm. Head pale grey. Palpi grey. Antennae whitish-grey; ciliations in male $\frac{1}{2}$, bristles 1. Thorax grey-whitish; bases of tegulae and a subanterior transverse line fuscous. Abdomen whitish-grey. Legs whitish. Forewings suboval, costa gently arched, apex rounded, termen obliquely rounded; ochreous-whitish; markings and some irroration fuscous; a triangular patch on base of costa, a basal dot, and three posterior marginal dots dark fuscous; a spot on mid-dorsum connected with basal patch; a dot on midcosta and a spot on $\frac{2}{3}$, both suffusedly connected with dorsal spot; a dark fuscous discal dot at $\frac{2}{3}$; an irregular subapical costal spot connected by a line of dots, angled inwards above middle, with $\frac{2}{3}$ dorsum; dark fuscous streaks on veins in terminal area; cilia grey, apices grey-whitish. Hindwings with termen gently rounded; whitish; cilia whitish.

Queensland: Herberton in April; one specimen received from Mr. W. B. Barnard, who has the type.

167. Philenora chionastis.

Scaeodora chionastis Meyr. l.c., p. 801.

Philenora chionastis Hmps. ii., p. 510, Pl. 33, f. 12.

Comarchis obliquata Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1082.

Queensland: Yeppoon; Bundaberg; Gympie; Nambour; Brisbane; Stradbroke Island; Tweed Heads; Rosewood; Toowoomba; Killarney. New South Wales: Lismore; Sydney. Victoria: Melbourne.

168. Philenora pteridopola.

Philenora pteridopola Turn. Proc. Roy Soc. Vic., 1922, p. 31.

Queensland: Atherton Plateau; Mount Tamborine; Macpherson Range (2,500-4,000 feet). New South Wales: Allyn River; Robertson; Mount Wilson.

169. Philenora cataplex n.sp.

καταπληξ, timid.

♂. 16 mm. Head whitish-ochreous. Palpi 1; fuscous. Antennae fuscous; ciliations in male $\frac{1}{2}$. Thorax grey with a whitish posterior spot. Abdomen ochreous-whitish. Legs grey; posterior pair ochreous-whitish. Forewings narrow, scarcely dilated, costa slightly arched, apex rounded, termen nearly straight, slightly oblique; whitish-ochreous; a narrow fuscous basal fascia produced on costa to $\frac{1}{3}$; dark fuscous discal dots at $\frac{2}{5}$ and $\frac{3}{5}$; a terminal fascia, not touching margin beneath apex and above dorsum; cilia whitish-ochreous with fuscous bars, on dorsum fuscous. Hindwings with termen slightly rounded; ochreous-whitish with slight grey suffusion towards apex; cilia ochreous-whitish.

North Queensland: Ravenshoe in January and February; two specimens received from Mr. F. P. Dodd.

170. *Philenora omophanes.*

Scaeodora omophanes Meyr. l.c., p. 731.

Philenora omophanes Hmps. ii., p. 512.

♂. 16 mm. Head whitish; face and palpi brownish-fuscous. Antennae fuscous; ciliations in male $\frac{1}{2}$. Thorax whitish; tegulae brownish fuscous. Abdomen grey; tuft grey-whitish. Legs fuscous. Forewings elongate-triangular. costa slightly arched, apex round-pointed, termen straight, not oblique; brownish-fuscous; an outwardly slightly darker line edged anteriorly with whitish, from $\frac{2}{5}$ costa to midtermen; a transverse discal mark at $\frac{2}{3}$ connected with costa; a wavy line from $\frac{4}{5}$ costa to $\frac{3}{4}$ dorsum, obtusely angled in middle, followed on dorsum by a whitish dot; cilia fuscous with some narrow pale bars opposite veins. Hindwings with termen rounded; reddish-fuscous, thinly scaled; cilia concolorous.

This is probably the same as Meyrick's species. He recorded that the type, which I have not seen, was in poor condition.

Victoria: Melbourne; Beaconsfield in November and December; two specimens received from Mr. Geo. Lyell, who has the type.

57. Gen. NOTATA.

Hmps. Ill. Lep. Het., viii., p. 47 (1891), and ii., p. 506.

Tongue well developed. Palpi short, porrect, smooth, slender, acute. Antennae in male simple. Posterior tibiae with middle spurs. Forewings with 2 from middle, 3 from before angle, 4 and 5 well separate. 6 from below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from $\frac{3}{4}$, free. Hindwings with 2 from middle, 3 from before angle, 4 and 5 well separate, 6 and 7 stalked, 12 anastomosing to end of cell in male, to near end in female. Type, *N. parva* Hmps., from India. There are only two species. Though approaching *Philenora* in structure, it may not be closely allied. The simple male antennae are an unusual character.

171. *Notata modica.*

Diphtheraspis modicus Luc. Proc. Roy. Soc. Q., 1892, p. 74.

Notata modica Hmps. ii., p. 506, Pl. 33, f. 23.

Queensland: Cooktown; Cairns; Atherton Plateau; Eungella; Nambour; Brisbane.

58. Gen. PARELICTIS.

Meyr. l.c., p. 709. Hmps. ii., p. 521.

Tongue well developed. Palpi moderate, ascending; second joint thickened with appressed scales; terminal joint short, obtuse. Antennae in male with cilia and bristles. Posterior tibiae with two pairs of long spurs. Forewings with 2 from near angle, 3, 4, 5 separate, 6 from below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from $\frac{3}{4}$, free. Hindwings with 2 from towards angle, 3 and 4 separate, 5 absent, 6 and 7 stalked, 12 anastomosing to middle of cell. Monotypical.

172. *Parelictis saleuta.*

Parelictis saleuta Meyr. l.c., p. 709. Hmps. ii., p. 521.

New South Wales: Ebor; Sydney. Victoria: Melbourne.

59. Gen. CASTULO.

Wlk. ii., p. 561. Hmps. ii., p. 522.

Tongue well developed. Palpi moderate, porrect; second joint thickened with appressed scales; terminal joint short, obtuse. Antennae of male bipectinate to apex, pectinations long. Posterior tibiae with two pairs of long spurs. Forewings with 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 from below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from $\frac{2}{3}$, free. Hindwings with 2 from $\frac{3}{4}$, 3 and 4 approximated or connate at origin, 5 remote, 6 and 7 connate, 12 anastomosing with cell to $\frac{1}{5}$ or less. Female unknown, probably apterous. Type, *C. plagiata*. Australian.

173. Castulo plagiata.

Castula plagiata Wlk., ii., p. 562. Hmps. ii., p. 522.

New South Wales: ———. Victoria: Sale. Tasmania: Dunalley.

174. Castulo doubledayi.

Castulo doubledayi Newm. Trans. Ent. Soc., 1956, p. 55. Hmps. ii., p. 522, Pl. 34, f. 1.

Cluaca rubricosta Wlk., xxxi., p. 268. Meyr. l.c., p. 716.

Castulo binotata Wlk. Undesc. Lep Het., p. 65.

New South Wales: Ebor. Victoria: Melbourne; Beaconsfield; Fernshaw; Gisborne; Gunbower. Tasmania: Launceston; Wilmot; Derby; Coles Bay; Russell Falls; Hobart.

60. Gen. TERMESSA.

Newm. Trans. Ent. Soc., 1856, p. 285. Meyr. l.c., p. 709.

Tongue well developed. Palpi moderate, porrect; second joint thickened with appressed scales; terminal joint short, obtuse. Antennae of male with cilia and bristles (in *T. terpnodes* with tufts of cilia arising from extremely short pectinations). Tibial spurs of moderate length; posterior tibiae with middle spurs. Forewings with 2 from $\frac{3}{4}$, 3, 4, 5 separate, 6 from below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from $\frac{2}{3}$, free. Hindwings with 2 from $\frac{3}{4}$, 3, 4, 5 somewhat approximated, often equidistant, 6 and 7 approximated or connate, 12 anastomosing to $\frac{1}{5}$. Type, *T. shepherdi*. Like the two preceding genera this is purely Australian. It is best distinguished by the smaller approximation of 3 and 4 of the hindwings and the structure of the male antennae.

KEY TO SPECIES.

1.	Forewings with apex more or less falcate ..	2	
	Forewings with apex not falcate	3	
2.	Forewings with fasciae not reaching costa ..		*conographa*
	Forewings with fasciae reaching costa		*discrepans*
3.	Forewings fuscous	4	
	Forewings not fuscous	5	
4.	Forewings with yellow spots		*terpnodes*
	Forewings without yellow spots		*catocalina*
5.	Forewings with blackish fasciae	6	
	Forewings without fasciae	10	
6.	Forewings with postmedian fascia much broader on costa		*shepherdi*

	Forewings with postmedian fascia not broader on costa	7	
7.	Forewings with costal edge blackish		*zenophanes*
	Forewings with costal edge not blackish	8	
8.	Thorax with anterior edge yellow		*congrua*
	Thorax with anterior edge blackish	9	
9.	Forewings with antemedian fascia with pale or yellow centre		*gratiosa*
	Forewings with antemedian fascia not pale-centred		*laeta*
10.	Forewings with blackish dots on termen	11	
	Forewings without terminal dots		*amorpha*
11.	Fore and hindwings white		*nivosa*
	Fore and hindwings pale ochreous-brown ..		*orthocrossa*

175. *Termessa conographa.*

Termessa conographa Meyr. l.c., p. 714.

Castulo conographa Hmps. ii., p. 523, Pl. 34, f. 27.

Queensland: Atherton Plateau; Maryborough; Brisbane; Bunya Mountains; Mount Tambourine; Macpherson Range (2,000 feet); Tweed Heads. New South Wales: Lismore.

176. *Termessa discrepans.*

Termessa discrepans Wlk., xxxi., p. 265. Meyr. l.c., p. 714.

Castulo discrepans Hmps. ii., p. 523.

Termessa hamula Feld. Reis. Nov., Pl. 160, f. 5.

Queensland: Stanthorpe. New South Wales: ———. Victoria: Fernshaw.

177. *Termessa terpnodes* n.sp.

τερπνωδης, pleasant.

♂. 26-34 mm. Head orange-yellow. Palpi 1; orange-yellow, apices fuscous. Antennae fuscous; in male with very short pectinations (½), ending in tufts of cilia. Thorax ochreous-yellow; patagia and tegulae dark fuscous. Abdomen ochreous-yellow. Legs fuscous. Forewings triangular, costa gently arched, apex pointed, termen straight, slightly oblique; dark fuscous with ochreous-yellow spots; an elongate fascia-like spot from base of dorsum to ¼ costa; a median series of three spots, costal, subcostal, and dorsal of variable size, often confluent; a narrow dentate submarginal fascia not reaching tornus; cilia dark fuscous. Hindwings with termen rounded; ochreous-yellow; large dark fuscous apical and tornal spots, sometimes confluent; cilia dark fuscous on dorsum yellow.

Queensland: Milmerran in September and October; Injune in September; four specimens.

178. *Termessa shepherdi.*

Termessa shepherdi Newm. Trans. Ent. Soc., 1856, p. 285. Meyr. l.c., p. 711.

Castulo shepherdi Hmps. ii., p. 525.

Victoria: Beechworth; Melbourne; Gisbourne; Healesville.

179. Termessa zonophanes.

Termessa zonophanes Meyr. Proc. Lin. Soc. N.S.W., 1888, p. 921.

Castulo zonophanes Hmps. ii., p. 526, Pl. 34, f. 30.

Queensland: Warwick. Victoria: Wimmera.

180. Termessa congrua.

Termessa congrua Wlk., xxxi., p. 265. Meyr. l.c., p. 713.

Castulo congrua Hmps. ii., p. 524, Pl. 34, f. 8.

Queensland: Eidsvold; Gayndah; Brisbane; Tweed Heads. New South Wales: Sydney.

181. Termessa gratiosa.

Eutane gratiosa Wlk., xxxi., p. 239.

Termessa gratiosa Meyr. l.c., p. 712.

Castulo gratiosa Hmps. ii., p. 526, Pl. 34, f. 4.

Termessa diplographa Turn. Trans. Roy. Soc. S.A., 1899, p. 11.

Queensland: Eidsvold; Brisbane; Mount Tamborine; Toowoomba; Dalby; Bunya Mountains. New South Wales: Glen Innes; Murrurundi; Sydney. Victoria: Melbourne; Gisborne.

182. Termessa laeta.

Termessa laeta Wlk., vii., p. 1689. Meyr. l.c., p. 712.

Castulo laeta Hmps. ii., p. 535, Pl. 34, f. 34.

Termessa xanthomelas Low. Trans. Roy. Soc. S.A., 1892, p. 6.

Queensland: Atherton Plateau; Eungella; Yeppoon; Eidsvold; Gayndah; Brisbane; Mount Tamborine; Macpherson Range (2,500 feet); Toowoomba; Dalby; Bunya Mountains; Killarney; Stanthorpe. New South Wales: Lismore; Ebor; Murrurundi; Sydney; Mount Kosciusko (4,000 feet). Victoria: Melbourne; Gisborne. South Australia: Mount Lofty. West Australia: Albany.

183. Termessa catocalina.

Clisobara catocalina Wlk., xxxi., p. 269.

Termessa catocalina Meyr. l.c., p. 711.

Castulo catocalina Hmps. ii., p. 526.

New South Wales: Sydney; Katoomba.

184. Termessa nivosa.

Lerna nivosa Wlk., xxxiii., p. 805. Meyr. l.c., p. 710.

Castulo nivosa Hmps. ii., p. 523.

Queensland: Stanthorpe. New South Wales: Ebor; Murrurundi; Gosford; Sydney; Jervis Bay. Victoria: Melbourne; Gisborne.

185. Termessa orthocrossa.

Termessa orthocrossa Turn. Proc. Roy. Soc. Vic., 1922, p. 32.

Queensland: Toowoomba.

186. Termessa amorpha n.sp.

ἀμορφος, unpleasing.

♂. 34 mm. Head pale brownish; face fuscous. Palpi 1½; fuscous-brown. Antennae grey; in male cilia ¾, bristles 1. Thorax whitish-grey with a posterior fuscous dot. Abdomen whitish-grey. Legs fuscous with whitish-grey rings; posterior pair whitish-grey. Forewings broadly triangular, costa slightly arched, apex rounded, termen rounded, scarcely oblique; whitish-grey; markings and some scattered scales fuscous; a fuscous mark on ⅓ costa and another on ⅓ dorsum; a transversely elongate dot in disc at ⅔; cilia whitish-grey. Hindwings with termen rounded; grey-whitish; a pale fuscous median discal dot; cilia grey-whitish.

West Australia: Mundaring, near Perth; one specimen received from Mr. R. Illidge.

61. Gen. CHAMAITA.

Wlk. J. Lin. Soc. Zool., 1862, p. 121. Hmps. ii., p. 530.

Tongue well developed. Palpi very short, loose-haired, acute. Antennae with basal joint extremely long and covered with dense hairs; in male simple with very short bristles. Posterior tibiae with middle spurs; in male dorsum thickly covered with large scales. Forewings with 2 from near middle, 3 from before angle, 4 and 5 widely separate, 6 from upper angle, 7 and 8 stalked, 9 absent, 10 from near end of cell, 11 from towards end, free; 10 absent in male; costa with a fringe of long hairs. Hindwings with cell long (⅔); 2 from middle, 3, 4, 5 widely separate, 6 and 7 coincident, 12 anastomosing to ¼. Type, *C. trichopteroides* Wlk. from India. Small Papuan genus with one species from India and one from Formosa.

187. Chamaita barnardi.

Nudaria barnardi Luc. Proc. Lin. Soc. N.S.W., 1893, p. 135. Hmps. Suppl. i., p. 804, Pl. 41, f. 30.

North Queensland: Cairns; Innisfail.

62. Gen. NUDARIA.

Haw. Lep. Brit. 156. Hmps. ii., p. 533.

Tongue present. Palpi very short, hairy. Antennae with basal joint large and covered with dense hairs; in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from ⅔, 3 from before angle, 4 and 5 widely separate, 6, 7, 8 stalked, 9 absent, 10 from near end of cell, 11 from towards end, free. Hindwings with 2 from middle, 3 from before angle, 4 and 5 widely separate, 6 and 7 stalked or coincident, 12 anastomosing to middle of cell. Type, *N. mundana* Lin., from Europe. A small Indo-malayan genus with single species in Europe and Australia.

188. Nudaria mollis.

Nudaria mollis Luc. Proc. Lin. Soc. N.S.W., 1893, p. 136. Hmps. ii., p. 536, Pl. 34, f. 24.

Psilopepla mollis Turn. Trans. Roy. Soc. S.A., 1899, p. 13.

Hindwings with 6 and 7 coincident.

Queensland: Cairns; Atherton Plateau; Eungella; Nambour; Brisbane; Mount Tamborine. New South Wales: Lismore.

63. Gen. SCHISTOPHLEPS.

Hmps. Ill. Het, viii., p. 53, and l.c. ii., p. 527.

Tongue present. Palpi short, porrect, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from ⅗, 3 from before angle, 4 and 5 widely separate, 6 from below upper angle, 7 and 8 stalked, 9 and 10 stalked, 11 from towards end of cell, approximated, connected, or astomosing with 12, 12 connected by three or four veinlets with costa. Hindwings with 2 from ¾, 3 from before angle, 4 and 5 widely separate, 6 and 7 stalked, 12 anastomosing almost to end of cell. Type, *S. bipuncta* Hmps., from India. A small Papuan genus with one species from India.

189. Schistophleps albida.

Nudaria albida Wlk., xxxi., p. 273.

Phaneropseustis adbida Turn. Trans. Roy. Soc. S.A., 1899, p. 12.

Schistophleps albida Hmps. ii., p. 528, Pl. 34, f. 9.

Queensland: Cairns; Innisfail; Atherton Tableland; Cardwell; Ingham; Rockhampton; Yeppoon; Bundaberg; Marborough; Noosa; Nambour; Brisbane; Stradbroke Island. New South Wales: Lismore.

190. Schistophleps obducta.

Nudaria obducta Luc. Proc. Lin. Soc. N.S.W,. 1893, p. 135.

Phaneropseustis obducta Turn. Trans. Roy Soc. S.A., 1899, p. 13.

Schistophleps obducta Hmps. ii., p. 528, Pl. 34, f. 10.

Queensland: Atherton Plateau; Townsville; Brisbane.

64. Gen. PORPHYROCHRYSA nov.

πορφυροχρυσος, purple and gold.

Tongue well developed. Palpi very short, slender, acute, ascending. Antennae in male ciliate. Posterior tibiae with middle spurs. Forewings with cell very narrow towards base, 2 from ⅗, 3 from angle connate with 4 and 5, which are stalked, 6 from well below upper angle. 7, 8, 9 stalked, 9 separating before 7, 10 from ⅗, 11 from middle, free. Hindwings with 2 from near angle, 3 and 4 stalked, 5 from middle of cell, 6 and 7 stalked, 12 anastomosing with cell to middle.

191. Porphyrochrysa dochmoschema n.sp.

δοχμοσχημος, with oblique pattern.

♂ ♀. 14-16 mm. Head yellow. Palpi yellowish. Antennae pale grey; ciliations in male 2. Thorax anteriorly yellow, posteriorly lustrous purple. Abdomen whitish-ochreous. Legs whitish-ochreous; anterior pair ochreous. Forewings suboblong, costa moderately arched, apex rounded, termen rounded, not oblique; yellow with purple markings; an oblique line on base of dorsum; a narrow oblique fascia from ⅓ costa

to mid-dorsum, a submarginal fascia from shortly before apex to tornus, both margins convex; cilia yellow. Hindwings with termen gently rounded; whitish-ochreous; cilia whitish-ochreous. In one female example the dorsal line and antemedian fascia are confluent.

North Queensland: Cape York in October, November, and May; four specimens received from Mr. W. B. Barnard, who has the type.

65. Gen. HETEROTROPA nov.

ἑτεροτροπος, of a different sort.

Tongue well developed. Palpi short, slender, smooth, acute, porrect or somewhat ascending. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{3}{4}$, 3 and 4 stalked from angle, 5 absent, 6 from upper angle, 7 and 8 stalked, 9 absent, 10 from well end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from near end of cell, 3 and 4 approximated or stalked, 5 absent, 6 and 7 stalked, 12 anastomosing with cell to beyond middle.

192. Heterotropa fastosa n.sp.

fastosus, proud.

♂ ♀. 15-20 mm. Head snow-white. Palpi brownish. Antennae grey; ciliations in male 1. Thorax with anterior half white, posterior grey-brown. Abdomen pale ochreous, towards base grey. Legs pale ochreous. Forewings suboblong, costa strongly arched, apex rounded-rectangular, termen straight, not oblique; grey-brown; a white longitudinally oval spot on base of costa; a triangular spot on costa before middle, ochreous in costal portion, white at apex, which does not reach middle of disc; an erect white bar from mid-dorsum, not reaching apex of coastal triangle; costal edge beyond triangle ochreous; terminal edge white; cilia ochreous. Hindwings gently rounded; grey, towards base pale ochreous; cilia pale ochreous.

North Australia: Darwin in December. North Queensland: Cape York in October, November, and March; Kuranda in September; eight specimens.

66. Gen. BAEOMORPHA nov.

βαιομορφος, small.

Tongue well developed. Palpi short, smooth, slender, acute, porrect. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$, 3 from angle connate with 4 and 5, which are stalked, 6 from below upper angle, 7 and 8 stalked, 9 absent, 10 from well before angle, 11 from $\frac{2}{3}$, free. Hindwings with 2 from near angle, 3 and 4 coincident, 5 somewhat approximated, 6 and 7 stalked, 12 anastomosing to middle of cell.

193. Baeomorpha cleta n.sp.

κλητος, welcome.

♂. 12-13 mm. Head white. Palpi grey. Antennae grey; ciliations in male $1\frac{1}{2}$. Thorax fuscous; patagia and tegulae white. Abdomen whitish-grey. Legs whitish; anterior pair grey. Forewings suboval, costa strongly arched, apex rounded, termen obliquely rounded; white

with two narrow oblique purple-fuscous fasciae; first from $\frac{1}{3}$ costa to middorsum; second from $\frac{2}{3}$ costa to tornus; cilia pale grey, on tornus fuscous. Hindwings with termen rounded; grey-whitish; cilia grey-whitish.

North Queensland: Cape York in October and November; two specimens received from Mr. W. B. Barnard, who has the type.

67. Gen. DIDUGA.

Moore Lep. Ceyl., ii., p. 535. Hmps ii., p. 539.

Tongue present. Palpi short, porrect, smooth, slender, acute. Antennae in male ciliated. Posterior tibiae with middle spurs. Forewings with 2 from middle, 3 and 4 approximated from angle, 5 separate. 6 from below upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 from end of cell, 11 from $\frac{2}{3}$, free. Hindwings with 2 from near angle, 3 and 4 coincident, 5 separate, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *D. flavicostata.* A small Indo-malayan genus.

194. Diduga flavicostata.

Pitane flavicostata Snel. Tijd. v. Ent., xxiii., p. 92.

Diduga costata Moore Lep. Ceyl., iii., p. 535, Pl. 211, f. 8, 9.

Diduga fulvicosta Hmps. Ill. Het. viii.; p. 52, Pl. 140, f. 16.

Diduga flavicostata Hmps. ii., p. 541.

♂. 10-11 mm. Head pale yellow. Thorax anteriorly pale yellow, posteriorly fuscous. Forewings suboblong, costa slightly arched, apex rounded-rectangular, termen straight scarcely oblique; fuscous; a broad pale yellow costal streak, indented at $\frac{1}{3}$ and $\frac{2}{3}$, continued along termen to tornus, indented beneath apex and below middle; cilia pale yellow, on tornus fuscous. Hindwings with termen rounded; grey; cilia grey.

North Australia: Darwin. Also from the Archipelago and India.

68. Gen. HETERALLACTIS.

Meyr l.c., p. 703. Hmps. ii., p. 538.

Tongue well developed. Palpi short, ascending, smooth, slender, acute. Antennae in male ciliated. Forewings with 2 from towards angle, 3 and 4 stalked from angle, 5 absent, 6 connate with 7 and 8, which are stalked, 9, 10, 11 separate and free, 11 from $\frac{3}{4}$. Hindwings with 2 from near angle, 3 and 4 coincident, 5 somewhat approximated, 6 and 7 stalked, 12 anastomosing to middle of cell. Type, *H. euchrysa.* A small genus peculiar to Queensland and New Guinea.

KEY TO SPECIES.

1.	Forewings with antemedian yellcw fascia	2	
	Forewings with yellow costal triangle only ...		*trigonochrysa*
2.	Forewings with terminal yellow fascia	3	
	Forewings without terminal fascia	7	
3.	Forewings with basal dark fascia reaching $\frac{1}{3}$ dorsum	4	
	Forewings with basal fascia not reaching $\frac{1}{3}$ dorsum	5	
4.	Forewings with yellow fascia much narrowed on dorsum		*niphocephala*
	Forewings with yellow fascia of even width ..		*chrysauges*

5. Forewings with yellow fascia narrow on dorsum ..		*stenochrysa*
Forewings with yellow fascia broad throughout ..	6	
6. Forewings with basal fascia of even width ..		*microchrysa*
Forewings with basal fascia broader on dorsum ..		*euchrysa*
7. Forewings with basal fascia very narrow		*lophoptera*
Forewings with basal fascia reaching $\frac{1}{4}$ dorsum ..		*chrysopera*

195. Heterallactis chrysopera.

Heterallactis chrysopera Hmps., Suppl. i., p. 809.

♂. 16-17 mm. Head yellow. Thorax purple-fuscous; patagia and an anterior spot yellow. Abdomen grey. Legs grey-whitish. Forewings suboval, costa strongly arched, apex rounded, termen obliquely rounded; bright yellow; markings ochreous-grey with purple reflections; a basal fascia, its posterior edge slightly curved from $\frac{1}{5}$ costa to $\frac{1}{4}$ dorsum; a broad terminal fascia, its anterior edge from midcosta strongly sinuate to dorsum near tornus; a slight yellow suffusion at extreme apex; cilia grey. Hindwings with a strong costal expansion partly covered with androconia beneath and with distorted neuration; termen rounded; grey; cilia grey.

♀. 14-17 mm. Differs from male in posterior dark fascia being restricted on costa, its anterior edge strongly curved from $\frac{3}{4}$ costa, and in a defined yellow apical spot.

North Queensland: Cape York; Cairns. Also from New Guinea.

196. Heterallactis lophoptera n.sp.

λοφοπτερος, with crested wings.

♂ ♀. 18-20 mm. Head yellow. Palpi very small, brownish. Antennae fuscous; ciliations in male 1. Thorax purple-fuscous with an anterior yellow spot. Abdomen grey; tuft whitish-ochreous. Legs whitish-ochreous; anterior pair fuscous. Forewings suboblong, costa strongly arched, apex rounded, termen slightly rounded, oblique; in male with a strong ridge or flap of scales on costal edge to $\frac{3}{4}$, strongly angled and projecting near base, usually folded over on underside of wing, when expanded revealing a large area of androconia; bright yellow; a very small basal fuscous fascia; costal edge fuscous towards base; a broad terminal fascia edged by a blackish slightly waved and convex line from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum, lustrous violet anteriorly, posteriorly mostly brownish, posterior margin pale ochreous; cilia whitish, bases and apices fuscous. Hindwings with termen rounded; grey; in male a pale costal area containing a tuft of long hairs; cilia pale grey.

North Queensland: Kuranda in September and October; four specimens received from Mr. F. P. Dodd.

197. Heterallactis niphocephala n.sp.

νιφοκεφαλος, with snow-white head.

♀. 15 mm. Head white. Palpi very small; brownish. Antennae fuscous-brown. Thorax fuscous-brown with an anterior white spot. Abdomen grey-whitish. Legs ochreous-whitish; anterior tibiae white. Forewings suboblong, costa strongly arched, apex round-pointed, termen straight, slightly oblique; yellow; a broad basal purple-fuscous fascia, posterior edge convex from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum; post-median fascia somewhat circular, narrow on costa at $\frac{2}{3}$, broad on dorsum from $\frac{3}{5}$ to

tornus, anterior and posterior margins convex; cilia yellow. Hindwings with termen rounded; whitish-grey; cilia whitish-grey.

North Queensland: Cape York in November and April; two specimens received from Mr. W. B. Barnard, who has the type.

198. Heterallactis stenochrysa n.sp.

στενοχρυσος, narrowly golden.

♂. 15 mm. Head yellow. Palpi very small; brownish. Antennae fuscous; ciliations in male $1\frac{1}{4}$. Thorax fuscous with an anterior yellow spot. Abdomen fuscous. Legs ochreous-whitish; anterior pair brownish. Forewings suboblong, costa moderately arched, apex rectangular, termen straight, slightly oblique; yellow with two purple-fuscous fasciae; basal fascia moderate, straight-edged from $\frac{1}{6}$ costa to $\frac{1}{4}$ dorsum; postmedian very broad on dorsum from $\frac{2}{5}$ to tornus, narrowing near costa, which it touches at $\frac{5}{6}$, anterior margin strongly convex, posterior straight with a small median tooth; cilia yellow, on tornus fuscous. Hindwings with termen rounded; grey; cilia grey. Hindwings of male with costa strongly expanded and with a median tuft of hairs covering a patch of androconial scales on underside of forewings below cell.

North Queensland: Kuranda in November; one specimen received from Mr. F. P. Dodd.

199. Heterallactis microchrysa n.sp.

μικροχρυσος, small golden.

♂ ♀. 13-14 mm. Head bright yellow. Palpi very small; pale yellow. Antennae fuscous; ciliations in male $\frac{2}{3}$. Thorax fuscous with a large yellow anterior spot. Abdomen grey. Legs brownish; anterior pair fuscous. Forewings suboval, costa strongly arched, apex rounded, termen rounded, not oblique; bright yellow with two lustrous purple-fuscous fasciae edged darker; first basal, narrow, anterior edge straight, costal and dorsal margins of equal length; second subterminal, anterior edge from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, posterior concave from near apex to tornus, both slightly waved; cilia yellow. Hindwings with termen rounded; grey; cilia grey. Underside of forewing in male with a narrow patch of androconia covered by long hairs beneath posterior part of cell.

North Queensland: Cape York in October and November; seven specimens received from Mr. W. B. Barnard, who has the type.

200. Heterallactis chrysauges n.sp.

χρυσαυγης, bright golden.

♂ ♀. 14-18 mm. Head bright yellow. Palpi very small; brownish. Antennae fuscous; in male minutely ciliated with longer paired bristles (1). Thorax purple-fuscous with an anterior yellow spot. Abdomen grey. Legs brownish; posterior pair whitish-ochreous. Forewings suboblong. costa strongly arched, apex rectangular, termen straight, not oblique; bright yellow with two lustrous purple-fuscous fasciae; basal fascia oblique, straight edged from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; postmedian broad, anterior edge from midcosta or beyond, convex, posterior from costa before apex to tornus, convex, leaving a narrow terminal yellow fascia; cilia yellow. Hindwings with termen rounded; grey; cilia grey.

North Australia: Darwin in November and December (F. P. Dodd). North Queensland: Cape York in November, April, and June (W. B. Barnard). Six specimens.

201. Heterallactis euchrysa.

Heterallactis euchrysa Meyr. l.c., p. 703. Hmps. ii., p. 539.

Queensland: Cairns; Nambour; Brisbane. New South Wales: Lismore.

202. Heterallactis trigonochrysa n.sp.

τριγονοχρυσος, with golden triangle.

♂. 16 mm. Head bright yellow. Palpi small; brown, apices paler. Antennae pale fuscous; ciliations in male 1½. Thorax lustrous purple-fuscous with an anterior yellow spot. Abdomen grey; tuft grey-whitish. Legs ochreous-brown; posterior pair pale ochreous. Forewings suboblong, costa strongly arched, apex rectangular, termen straight, slightly oblique; lustrous purple-fuscous; markings bright yellow; a large triangular spot on costa from near base to middle, its apex rounded, not reaching dorsum; a narrow terminal fascia, its anterior margin from ⅘ costa to tornus, slightly indented in middle; cilia yellow. Hindwings with termen rounded; in male with a large rounded costal expansion covering a patch of androconia on undersurface of forewing; pale grey; cilia pale grey.

North Queensland: Cape York in November; two specimens received from Mr. W. B. Barnard, who has the type.

69. Gen. HEMONIA.

Wlk., xxviii., p. 420. Hmps. ii., p. 556.

Tongue present. Palpi short, porrect, smooth, slender, acute. Antennae of male bipectinate to ¾. Posterior tibiae with middle spurs. Forewings with cell long (¾); 2 from middle, 3 from near angle, 4 and 5 stalked, 6 and 7 connate or stalked, 8, 9, 10 separate, 11 from middle, connected by a bar with 12. Hindwings with cell long (⅔), 2 from well before angle, 3 and 4 stalked, 5 absent, 6 and 7 stalked, 12 anastomosing with cell to ¾. A small Indo-Malayan genus. Type, *H. orbiferana* Wlk., from India.

203. Hemonia micrommata.

Eurodes micrommata Turn. Trans. Roy Soc. S.A., 1899, p. 12.

Hemonia micrommata Hmps. ii., p. 556, Pl. 34, f. 21.

North Australia: Darwin. Queensland: Cairns; Townsville; Lindeman I.; Yeppoon.

204. Hemonia peristerodes n.sp.

περιστερωδης, dove-coloured.

♂. 20 mm. Head and thorax grey. Palpi 1; ochreous-whitish. Antennae grey; pectinations in male 2. Abdomen whitish. Legs ochreous-whitish; anterior pair grey. Forewings broadly triangular, costa very strongly arched, apex rectangular, termen straight, not oblique; pale grey; a fuscous costal line to ⅘, thence strongly curved to tornus; terminal area beyond this darker grey with a fine dentate

interrupted fuscous submarginal line; a wavy transverse line from $\frac{1}{4}$ dorsum reaching more than half across disc; a minute fuscous discal dot at $\frac{2}{3}$; cilia grey. Hindwings with termen rounded; whitish; cilia whitish.

North Queensland: Cape York in October and November; three specimens received from Mr. W. B. Barnard, who has the type.

Subfam. ARCTIINAE.

Key to Genera.

1. Tongue obsolete or rudimentary, forewings without areole	2	
Tongue well developed, forewings with areole ..	7	
2. Palpi obsolete	..	*Heliocaes* 70
Palpi developed	3	
3. Palpi clothed with long rough hair, terminal joint concealed	..	*Phaos* 71
Palpi moderately hairy, terminal joint not concealed	4	
4. Femora hairy	5	
Femora not hairy	..	*Creatonotus* 72
5. Posterior femora with spurs obsolete	..	*Maenas* 73
Posterior femora with terminal spurs present ..	6	
6. Abdomen hairy	..	*Spilosoma* 74
Abdomen smooth	..	*Amsacta* 75
7. Areole long and narrow, 7 from areole connate with 8, 9	..	*Rhodogastria* 76
Areole not long and narrow, 7 separate from areole	..	*Cremnophora* 77

70. Gen. HELIOCAES nov.

ἡλιοκαης, sun-scorched.

Tongue and palpi rudimentary. Antennae of male bipectinate to apex. Posterior tibiae without middle spurs. Thorax hairy. Abdomen comparatively smooth. Forewings with 2 from towards angle, 3, 4, 5 approximated, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from towards end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3, 4, 5 somewhat approximated, 6 and 7 connate or stalked, 12 anastomosing to near middle of cell. Type, *H. cosmeta*.

205. *Heliocaes xanthotypa* n.sp.

ξανθοτυπος, with yellow markings.

♂. 28-32 mm. Head blackish. Antennae blackish; pectinations in male 8. Thorax blackish with a pair of orange spots on patagia. Abdomen blackish with orange rings on apices of segments. Legs blackish; dorsum of tibiae orange. Forewings triangular, costa straight, apex round-pointed, termen rounded, oblique; blackish with orange spots; a triangular subdorsal spot near base; two triangular antemedian spots separated by median vein; a postmedian series of two round spots with intermediate dots; a subterminal series of dots with a gap in middle followed by a round subtornal spot; cilia blackish. Hindwings with termen rounded; colour as forewings; a large sub-basal and smaller postmedian spots, often more or less confluent; a dot on midtermen; cilia blackish, on midtermen orange.

Queensland: Stanthorpe in October, November, and January; three specimens.

206. Heliocaes cosmeta.

Spilosoma cosmeta Low. Trans. Roy. Soc. S.A., 1907, p. 170.

Estigmene cosmeta Hmps., Suppl. ii., p. 430.

♂. 32-34 mm. Head fuscous. Antennae fuscous; pectinations in male 2. Thorax fuscous; patagia and tegulae partly whitish-ochreous. Abdomen fuscous, towards apex mixed with ochreous. Legs fuscous; femora and anterior coxae ochreous. Forewings elongate-triangular, costa straight, apex rounded, termen rounded, slightly oblique; fuscous; markings and some suffusion pale ochreous; a short streak on base of dorsum; two transverse series of small suffused spots; first sinuate from $\frac{3}{4}$ costa to $\frac{3}{5}$ dorsum; second subterminal, angled outwards in middle; cilia fuscous. Hindwings with termen rounded; ochreous-reddish; a discal spot and broad basal band fuscous, cilia fuscous; on tornus and dorsum ochreous.

New South Wales: Brewarrina; Bourke; Broken Hill. South Australia: Morgan; Mannum. North-west Australia: Broome.

71. Gen. PHAOS.

Wlk., iii., p. 627. Turn. Proc. Roy. Soc. Tas., 1925, p. 110.

Tongue obsolete. Palpi very short, clothed with long rough hair; terminal joint concealed. Antennae of male bipectinate to apex. Thorax and abdomen hairy. Anterior tibiae sometimes with two terminal hooks. Posterior tibiae with or without middle spurs. Forewings with 2 from $\frac{3}{4}$, 3, 4, 5 approximated, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from towards end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3 from near angle, 4 and 5 connate, 6 and 7 connate or stalked, 12 anastomosing to middle of cell. Female unknown; probably apterous. Type, *P. interfixa*. Probably allied to the New Zealand genus *Metacrias*, which has retained a small areole.

KEY TO SPECIES.

Forewings with dorsum dark fuscous	*interfixa*
Forewings with dorsum barred alternately blackish and ochreous	*aglaophara*
Forewings with dorsum orange-ochreous	*acmena*

207. Phaos interfixa.

Phaos interfixa Wlk., iii., p. 627. Turn. Proc. Roy. Soc. Tas., 1925, p. 111.,

Estigmene interfixa Hmps. iii., p. 339.

Tasmania: Mount Wellington (4,000 feet); Cradle Mountain (3,000 feet).

208. Phaos aglaophara.

Phaos aglaophara Turn. Trans. Roy Soc.. S.A., 1926, p. 120.

New South Wales: Mount Kosciusko (5,000-6,000 feet).

209. Phaos acmena.

Phaos acmena Turn. Proc. Roy. Soc. Tas., 1925, p. 112.

Estigmene interfixa Hmps., Pl. 47, f. 18.

Tasmania: Bothwell; Launceston.

72. Gen. CREATONOTUS.

Hb. Verz., p. 169. Hmps. iii., p. 331.

Tongue weak and imperfect. Palpi very short, hairy. Antennae of male shortly ciliated. Femora smooth. Posterior tibiae without middle spurs; terminal spurs very short. Thorax smooth. Forewings with 2 from $\frac{2}{3}$, 3, 4, 5 somewhat approximated, 6 from beneath upper angle, 7, 8, 9, 10 stalked, 11 from near end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 connate or stalked, 5 approximated, 6 and 7 approximated or connate; 12 anastomosing to middle of cell. Type. *C. gangis*. A small African and Indo-Malayan genus.

210. Creatonotus gangis.

Phalaena gangis Lin. Amoen. Acad., vi., p. 410.

Noctua interrupta Lin. Syst. Nat., i. (2), 840.

Bombyx francisca Fab. Mant Ins. ii., p. 131.

Creatonotus continuatus Moore Ann Mag. Nat. Hist. (4), xx., p. 344.

Phragmatobia interrupta Meyr. l.c., p. 802.

Creatonotus gangis Hmps. iii., p. 333.

North Australia: Darwin; Adelaide River. Queensland: Cairns; Innisfail; Atherton Plateau; Ingham; Townsville; Mackay. Also from the Archipelago, China, and India.

73. Gen. MAENAS.

Hb. Verz., p. 167. Hmps. iii., p. 247.

Tongue obsolete. Palpi short, porrect, rough-haired; terminal joint short, obtuse. Eyes sometimes thinly covered with fine hairs. Antennae of male bipectinate to apex. Femora hairy. Posterior tibiae without middle spurs; terminal spurs very short. Forewings with 2 from $\frac{2}{3}$, 3 from near angle, 4 and 5 connate, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from towards end of cell, free. Hindwings with 2 from middle, 3, 4, 5 approximated, 6 and 7 connate, 12 anastomosing with cell to $\frac{1}{3}$ or further. Thorax and abdomen hairy. Type, *M. vocula* Stoll, from South Africa. A genus of moderate size extensively distributed in both hemispheres.

211. Maenas maculifascia.

Spilosoma maculifascia Wlk., iii., p. 676.

Spilosoma conspurcatum Wlk., vii., p. 1628.

Lymantria parva Wlk., xxxii., p. 368.

Maenas maculifascia Hmps. iii., p. 249.

Maenas arescopa Turn. Trans. Roy Soc. S.A., 1906, p. 118.

North Queensland: Cairns; Atherton Plateau; Bowen. Queensland: Yeppoon, Also from the Archipelago.

74. Gen. SPILOSOMA.

Curtis Brit. Ent., ii., Pl. 92. Hmps., Suppl. ii., p. 363.

Tongue weak and imperfect. Palpi short, porrect, hairy; terminal joint short, obtuse. Eyes sometimes thinly covered with fine hairs. Thorax and abdomen hairy. Femora hairy. Posterior tibiae with middle spurs. Forewings with 2 from about middle, 3, 4, 5 approximated, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from towards end of cell, free. Hindwings with 2 from $\frac{2}{3}$, 3, 4, 5 approximated or connate, 12 anastomosing with cell to $\frac{1}{3}$. Type, *S. lubricipeda* Lin., from Europe. A large genus with representatives in all continental areas. *Spilosoma* Curtis has priority over *Diacrisia* Hb.

KEY TO SPECIES.

1. Hindwings black and orange		*platycroca*
Hindwings not black and orange	2	
2. Hindwings red or reddish	3	
Hindwings white	5	
3. Hindwings with fuscous terminal or subterminal band		*curvata*
Hindwings without terminal band	4	
4. Forewings with terminal fuscous dots		*erythrastis*
Forewings without terminal dots		*nobilis*
5. Thorax with lateral fuscous streaks		*glatignyi*
Thorax without lateral streaks		*canescens*

212. *Spilosoma curvata.*

Bombyx curvata Don. Inst. N. Holl., Pl. 34, f. 3.

Chelonia fuscinula Dbld. Eyre's Cent. Aust., i., p. 438, Pl. 5, f. 4.

Arctia vittata Moschl. Stett. Ent. Zeit., 1872, p. 351.

Phaos vigens Butl. P.Z.S., 1878, p. 383.

Phaos nigriceps Butl. ibid., p. 383.

Phaos notatum Butl. ibid., p. 383.

Phaos nexum Butl., p. 384.

Phaos lacteatum Butl. ibid., p. 384.

Spilosoma fuscinula Meyr. l.c., p. 752.

Spilosoma brisbanensis Luc. Proc. Lin. Soc. N.S.W., 1890, p. 1084.

Spilosoma quinquefascia Luc. ibid., p. 1085.

Ardices curvata Hmps. iii., p. 245.

This is a most variable species. Apart from individual variations, it tends to form local races; these are as follows:—

athertonensis with dark costal, median, and dorsal streaks from base to termen.

North Queensland: Atherton Plateau.

fuscinula-lacteata-brisbanensis with longitudinal streaks thinner and incomplete, followed by subterminal and terminal series of spots. Sydney examples are on the average darker than those from Queensland, but cannot be separated from them.

Queensland: Bundaberg; Gympie; Nambour; Brisbane; Mount Tamborine; Tweed Heads; Bunya Mountains. New South Wales: Lismore; Tyringham; Murrurundi; Newcastle; Sydney; Jervis Bay.

nexa-nigriceps-quinquefascia without longitudinal streaks but with four transverse fasciae more or less confluent, the basal fascia containing a whitish spot.

New South Wales: Ebor (4,500 feet); Mount Kosciusko (5,000 feet). Victoria: Melbourne; Beaconsfield.

vigens smaller than the preceding, darker, the fascia more completely confluent, and without basal white spot.

Tasmania: Georgetown; Geeveston; Bruni Island.

213. Spilosoma glatignyi.

Chelonia glatignyi Le Guil. Rev. Zool. 1841, p. 257.

Chelonia pallida Dbld. Eyre's Cent. Aust., i., p. 438, Pl. 5, f. 3.

Ardices fuvohirta Wlk., iii., p. 710.

Spilosoma subocellatum Wlk., vii., p. 1697.

Spilosoma conferta Wlk., xxxi., p. 295.

Spilosoma fulvohirta Meyr. l.c., p. 754.

Spilosoma queenslandi Luc. Proc. Roy. Soc. Q., 1898, p. 60.

Ardices garida Swin. Cat. Oxf. Mus., i., p. 179, Pl. 4, f. 7.

Ardices glatignyi Hmps. iii., p. 246.

Diacrisia garida Hmps. iii., p. 309.

Diacrisia meridionalis Roths. Nov. Zool. 1910, p. 134.

Ardices meridionalis Hmps., Suppl. ii., p. 352.

Variable. I regard *garida* as a melanic aberration.

Queensland: Macpherson Range. New South Wales: Sydney; Mount Wilson. Victoria: Melbourne; Gisborne. Tasmania: Waratah; Rosebery; Strahan; Mount Wellington; Hobart. South Australia: Kangaroo Island. West Australia: Albany; Perth.

214. Spilosoma canescens.

Ardices canescens Butl. Cist. Ent., ii., p. 29.

Spilosoma obliqua Meyr. (*nec.* Wlk.) l.c., p. 755.

Diacrisia canescens Hmps. iii., p. 287, Pl. 45, f. 4.

Queensland: Mount Tamborine; Macpherson Range (3,500 feet); Toowoomba; Bunya Mountains. New South Wales: Ebor; Sydney. Victoria: Melbourne. Tasmania: Launceston; Latrobe.

215. Spilosoma erythrastis.

Spilosoma erythrastis Meyr. l.c., p. 753.

Spilosoma frenchi Luc. Proc. Roy. Soc. Q., 1898, p. 59.

Diacrisia erythrastis Hmps. iii., p. 269, Pl. 44, f. 8.

North Queensland: Lizard Island; Cairns.

216. *Spilosoma nobilis*, n.sp.

nobilis, excellent.

♂. 56 mm. Head brown-whitish; lower half of face blackish. Palpi blackish; lower half red. Antennae blackish; ciliations in male 2. Thorax whitish-brown; two anterior spots on patagia, lateral streaks on tegulae, and a median streak, blackish. Abdomen red, on terminal segments mixed with yellow; with a median dorsal series of blackish spots. Legs dark fuscous; basal three fourths of tibiae and anterior coxae red. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen long, slightly rounded, oblique; ochreous-whitish with blackish markings; costal edge blackish as far as an oblique bar on $\frac{1}{3}$ costa representing antemedian line, which is continued by median and subdorsal dots; a second bar on $\frac{2}{3}$ costa with an angled series of dots to dorsum beyond middle; a subterminal series of dots from apex to tornus; cilia ochreous-whitish. Hindwings with termen rounded; yellowish, basal half suffused with red; a discal spot and subterminal series of spots blackish; cilia yellowish.

North Queensland: Millaa Millaa (3,000 feet) in September; one specimen.

217. *Spilosoma platycroca* n.sp.

πλατυκροκος, broadly saffron-hued.

♂. 36 mm. Head orange. Palpi $1\frac{1}{4}$; fuscous. Antennae blackish; pectinations in male 6. Thorax fuscous; patagia orange with a median fuscous streak. Abdomen orange; apices of segments dark fuscous. Legs smooth; fuscous, bases of femora ochreous. Forewings triangular, costa straight almost to apex, apex rounded, termen straight, moderately oblique; dark fuscous with orange markings; a subdorsal spot near base; a moderate fascia from beneath $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; another from beneath $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; a subterminal series of spots; cilia fuscous. Hindwings with termen slightly rounded; dark fuscous; a large basal patch extending to $\frac{1}{3}$ and an incomplete postmedian fascia orange; an orange dot on tornus; cilia fuscous, on tornus and dorsum orange.

This species ill accords with *Spilosoma*. The smooth femora would justify its removal from that genus, but this would entail a revision of the exotic genera, which I am not able to undertake.

North Australia: King River in January; type in National Museum, Melbourne.

75. Gen. AMSACTA.

Wlk., iv., p. 804. Hmps. iii., p. 322.

Tongue obsolete. Palpi moderately long, porrect, obtuse, thickened with appressed scales, somewhat hairy beneath. Antennae of male serrate, dentate, or (in exotic species) bipectinate. Thorax somewhat hairy. Abdomen smooth. Femora hairy. Anterior tibiae with an apical and subapical claw. Posterior tibiae without middle spurs, terminal spurs short. Forewings with 2 from near end of cell, 3, 4, 5 approximated from angle, or 4 and 5 stalked, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from near end of cell, free. Hindwings with 2 from $\frac{2}{3}$ or beyond, 3, 4, 5 approximated, or 4 and 5 stalked, 6 and 7 connate or stalked, 12 anastomosing to middle of cell. Type, *A. marginalis* Wlk., from Africa. An Indo-Malayan and African genus of some size.

218. *Amsacta gangara.*

Aloa gangara Swin. Cat. Oxf. Mus., i., p. 171, Pl. 4, f. 2.

Amsacta gangara Hmps. iii., p. 326.

West Australia: Albany; Beverley; Perth; Merredin.

219. *Amsacta eurymochla.*

Amsacta eurymochla Turn. Proc. Roy. Soc. Tas., 1926, p. 119.

Victoria: Warragul. Tasmania: Beaconsfield.

220. *Amsacta marginata.*

Phalaena marginata Don. Ins. N. Hol., Pl. 34, f. 2.

Areas marginata Meyr. l.c., p. 755.

Areas roseicostis Butl. Cist. Ent., ii., p. 23.

Areas punctipennis Butl. Ann. Mag. Nat. Hist. (4), xviii., p. 126.

Amsacta marginata Hmps. iii., p. 330.

North Australia: Darwin; Brock's Creek. Queensland: Thursday Island; Cooktown; Atherton Plateau; Mount Mulligan; Dunk Island; Charters Towers; Rockhampton; Eidsvold; Gayndah; Brisbane; Mount Tamborine; Toowoomba; Nanango; Stanthorpe; Milmerran; Miles; Charleville. New South Wales: Tabulam; Murrurundi; Scone; Newcastle; Sydney. South Australia: Port Lincoln. North-west Australia: Sherlock River; Condon; Monteballo Island. Also from New Guinea.

221. *Amsacta costalis.*

Aloa costalis Wlk., xxxi., p. 301.

Aloa corsima Swin. Cat. Oxf. Mus., i., p. 171, Pl. 4, f. 1.

Amsacta costalis Hmps. iii., p. 326.

North Australia: Darwin; Port Essington. North Queensland: Thursday Island; Mareeba; Townsville. North-west Australia: Kimberley; Wyndham.

76 Gen. RHODOGASTRIA.

Hb. Verz., p. 172. Hmps., iii., p. 498.

Tongue strongly developed. Palpi moderately long, ascending, smooth, rough-scaled towards base beneath; terminal joint long, obtuse. Antennae of male minutely ciliated with very short bristles. Thorax and femora smooth. Posterior tibiae with middle spurs. Forewings with 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 from well below upper angle, 7, 8, 9 stalked, 10 almost from end of cell, connected with 8 by an oblique bar to form a long narrow areole, 11 from $\frac{3}{4}$, free. Hindwings with 2 from $\frac{2}{3}$, 3, 4, 5 separate, 12 anastomosing nearly to end of cell. Type, *R. astreas* Drury. A large Indo-Malayan and African genus.

KEY TO SPECIES.

1. Forewings wholly white	2	
Forewings not wholly white	3	
2. Abdomen rosy		*alberta*
Abdomen yellowish-brown		*rubripes*
3. Forewings uniformly grey or whitish		*serica*
Forewings not uniformly grey or whitish	4	

222. *Rhodogastria rubripes.*

Amerila rubripes Wlk., xxxi., p. 304. Meyr. l.c., p. 766.

Rhodogastria rubripes Hmps. iii., p. 500.

North Australia: Darwin. Queensland: Thursday Island; Cape York; Cooktown; Cairns; Innisfail; Atherton Plateau; Dunk Island; Ingham; Townsville; Bowen; Rockhampton; Gympie; Brisbane. North-west Australia: Wyndham.

223. *Rhodogastria alberti.*

Rhodogastria alberti Roths. Nov. Zool., 1910, p. 186. Hmps., Suppl. ii., p. 530.

North Queensland: Cooktown; Cairns; Atherton Plateau.

224. *Rhodogastria serica.*

Amerila serica Meyr. l.c., p. 765.

Rhodogastria serica Hmps. iii., p. 505.

Queensland: Rockhampton; Gayndah; Brisbane; Toowoomba.

225. *Rhodogastria timiolis.*

Rhodogastria timiolis Turn. Proc. Lin. Soc. Q., 1915, p. 20. Hmps., Suppl. ii., p. 518, Pl. 68, f. 23.

North Australia: Melville Island. North Queensland: Cape York; Cairns; Dunk Island; Townsville.

It is possible that the female specimen described by Meyrick (l.c., p. 764) as *Amerila astraeas* Drury may be an example of this species.

226. *Rhodogastria crokeri.*

Euprepia crokeri Macl. King's Surv. Aust., ii., p. 465.

Amerila brachyleuca Meyr. l.c., p. 765.

Rhodogastria croceri Hmps. iii., p. 504, Pl. 50, f. 14.

North Australia: Darwin. Queensland: Cooktown; Atherton Plateau; Dunk Island; Bowen; Bundaberg; Gayndah; Brisbane. New South Wales: Lismore. North-west Australia: Wyndham. Also from New Guinea.

77. Gen. CREMNOPHORA.

Hmps. iii., p. 453.

Face with a conical prominence. Tongue well developed. Palpi rather long, porrect, smooth, but rough-haired at base beneath, obtuse. Antennae of male bipectinate to apex. Thorax smooth above with a rough posterior crest; hairy beneath. Femora hairy. Posterior tibiae with two pairs of well-developed spurs. Forewings with areole present; 2 from $\frac{2}{3}$, 3, 4, 5 separate, 6 from well below upper angle, 7, 8, 9 stalked from areole, 10 separate from areole, 11 from $\frac{2}{3}$, free. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 approximated, 5 separate, 6 and 7 approximated, 12 anastomosing with cell to $\frac{1}{3}$. Monotypical.

227. Cremnophora angasii.

Apina angasii Wlk., iii., p. 757.

Cremnophora angasi Hmps. iii., p. 453.

Victoria: Brentwood. South Australia: Murray Bridge; Moonta. West Australia: Coolgardie; Quairading.

Species unrecognised.

228. *Comarchis gradata* Luc. Proc. Lin. Soc. N.S.W., 1889, p. 1081. Toowoomba.

229. *Mosoda bancrofti* Luc. ibid., p. 1077. Brisbane.

230. *Mosoda lineata* Luc. ibid., p. 1078. Brisbane.

231. *Thallarcha aurantiaca* Luc. ibid., p. 1080. Brisbane.

232. *Choorechillum distitans* Luc. Proc. Roy. Soc. Q., 1901, p. 73. This is a synonym of ***Abraxas flavimacula*** Warr. (Boarmiadae)[1]

233. *Burnia intersecta* Luc. Proc. Roy. Soc. N.S.W., 1889, p. 1070. This is a synonym of *Xylorycta porphyrinella* Wlk.

234. *Anestia trissodesma* Low. Proc. Lin. Soc. N.S.W., 1897., p. 12. Belongs to the genus *Anomocentris* (*Larentiidae*).

235. *Chundana lugubris* Wlk. J. Lin. Soc. Zool., 1862, p. 117. Belongs to the *Epiplemidae*.

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INDEX TO SPECIES.

Synonyms and species unrecognised or wrongly referred in italics.

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VOLUME LI., PART 2.

NOTES ON AUSTRALIAN MUSCOIDEA, V.

Calliphoridae.

BY G. H. HARDY.

(*Read before the Royal Society of Queensland, 27th November, 1939.*)

A key to subfamilies of the Calliphoridae was given in the first part of this series of papers (Hardy 1934), and the genera known to me under the Rhiniinae, Chrysomyiinae, and Calliphorinae are to be recognised by the characters given in the following key:—

1. Without forwardly directed fronto-orbital bristles on the female. Sternopleurals 1:1. Palpi conspicuously flattened. Only a few thoracic bristles present. The ridge of the squama bare	2
With one pair of forwardly directed fronto-orbital bristles on female. Arista long plumose. Thoracic bristles well developed	4
With a series of more or less forwardly directed fronto-orbital bristles on female, parallel with those bordering the interfrontalia. Sternopleurals 1:1. Palpi conspicuously flattened. Cheeks hairy, at least microscopical. Arista pubescent or bare. Thoracic bristles well developed. Squama and ridge bare ..	*Metallea*
2. Squama bare above. Arista more or less sparsely plumose or pubescent	3
Squama very hairy above. Arista densely pubescent ..	*Chrysomyia*
3. A metallic green species on which the wings, when at rest, bend downwards from the basal cells, thus, in life, lying along the depressed abdomen they give the superficial appearance of a beetle. The fifth radial and first median veins meet before the wing margin	*Chlororhina*
Otherwise coloured species with normal wings, and if the fifth radial and first median veins meet, then the abdomen is brown	*Rhinia*
4. Fifth sternite of male not cleft or emarginated in any way at the apex, and with a well developed subapical spine. Otherwise liable to be confused with *Pollenia*	*Aphyssura n.gen.*
Fifth sternite of male cleft along the median line, the two sides contiguous, or else widely V-shaped	5
5. Squama usually hairy on the upper side, though often inconspicuously so or the hairs are absent; in these two latter cases the species is small and with a metallic blue-green abdomen. Other characters also very variable	*Calliphora*
Squama always bare. If very small species, then the abdomen is not blue-green	6
6. Sternopleural bristles arranged 2:1	7
Sternopleural bristles arranged 1:1. Area of thorax below squama bare	8
7. Area of thorax immediately below squama with hairs ..	*Lucilia*
Area of thorax immediately below squama entirely bare ..	*Euphumosia*
8. Cheeks hairy and thoracic bristles long	*Pollenia*
Cheeks bare and thoracic bristles unusually short ..	*Paratrichlea*

This key omits *Acanthomyza*, which is very poorly described, and I do not know if I have it correctly identified. *Dexopollenia* Bezzi 1927, p. 231, is not in any collection I have seen.

Subfamily RHINIINAE.

Key to genera of the *Rhiniinae*.

1. Facial carina well developed, but with a rounded dorsal surface, showing its tendency towards reduction. Arista with conspicuous cilia above. Without marked bristles on the dorsum of thorax and abdomen. Fifth radial cell open or closed. Closely pitted above with hair-pits	*Rhinia*
Facial carina very much reduced. Arista only pubescent. Hair-pits on body above reduced to hair-spots ..	2
2. Fifth radial and first median veins meeting before wing border, and the whole wing tends to fold at the apex of the basal cells. Without marked bristles, but with coarse hair-spots. Entirely metallic green, with a large blackish disc on the depressed abdomen ..	*Chlororhina*
Venation normal. Thorax with complete bristles and reduced hair-pots	*Metallea*

Genus *Rhinia* Desvoidy.

Key to species of *Rhinia*.

1. Fifth radial and first median veins meeting before wing margin. Abdomen mainly brown, but slightly marked	*xanthogaster* Wied.
Fifth radial and first median veins not meeting. Abdomen conspicuously marked with bands	2
2. Species of small average size, more bluish in colour, eyes almost contiguous on the male, and the parafrons of the female with coarse hair-pits	*subapicalis* Macq.
Species of larger average size, more coppery coloured, eyes separated on the male by the width of one ocellus, and the parafrons of the female with abundance of very small hair-pits	*cribellata* Bezzi.

I have not seen *Rhinia pallida* Malloch 1927, which is said to have scutellum and legs testaceous and is from North Queensland. The other three have an involved synonymy which I believe to be interpreted correctly here.

Rhinia xanthogaster Wiedemann.

Idia xanthogaster Wiedemann 1830, 349.—Senior-White 1924, 113 (*Idielliopsis*).—Senior-White 1925, 93 (*Stomorhina*)—Bezzi 1927, 234 (*Stomorhina*).—Malloch 1927, 334 (*Stomatorhina*).—Malloch 1928, 612 (*Rhinia*).

Idia australis Walker 1849, 809.—Brauer and Bergenstamm 1893, 220.

Although this synonymy was given by Senior-White, Malloch gives Walker's name as a synonym of *subapicalis* Macq. The description agrees as here given, and Austen labelled a specimen with Walker's name. An allied form from Palm Island has entirely yellow legs and no markings on the abdomen. The present species is known from Queensland and New South Wales.

Rhinia subapicalis Macquart.

Idia subapicalis Macquart 1847, 82.—nec Malloch 1927.

Euidiella discolor Senior-White 1924, 112 (Australian specimens only)—Senior-White 1925, 93 (*Stomorhina*).—Bezzi 1927, 234 (Australian record only)—Malloch, 1927, 334 (*Stomatorhina*).

Idia murina Schiner 1868, 309.—Brauer and Bergenstamm, 1891, 418.

Stomorhina subapicalis Bergroth, 1894, 74.

Stomatorhina quadrinotata Malloch, 1927, 332.

Senior-White recorded some of this synonymy, and an attempt is made here to bring about a better understanding of the Australian element. Malloch brings in Bigot's name *quadrinotata* from Java, but does not show if this be conspecific as claimed. Moreover, the species as now standing might be a complex of two species, both of which have two rows of very coarse hairpits on the parafrons of the female. The eye marks of both forms have a green band at antennal level, with three more green bands above and five below; thus of the red field there are eight red bands and two blotches left in one case, in the other the eye marks are the same, except that both the upper and lower blotches are isolated by green from the eye margin and hence are reduced each to an elongated somewhat band-like spot. Except for a slight difference in the spacing of the bands, the eye-markings are similar on both sexes, and in all cases the uppermost and lowermost bands of red tend towards black. The species is common in New South Wales and Queensland.

Rhinia cribellata Bezzi.

Stomorhina cribellata Bezzi, 1927, 233.—Malloch, 1927, 334.

Stomatorhina subapicalis Malloch, 1927, 333.—nec Macquart.

This synonymy is new. The female has many more hair-pits on the parafrons than has *subapicalis* Macquart, and these are arranged usually in three distinct rows, and invariably so towards the anterior part. My note on the eye marks gives only eight green bands all separated from the posterior margin, so that the red bands between them join the two red blotches along that margin. As in the prior case the uppermost and lowermost bands of red tend towards blackish. The species occurs in Queensland, New South Wales, Victoria, and South Australia.

Genus *Chlororhina* Townsend, 1917.

Chlororhina viridis Townsend.

Townsend 1917, 191.—Malloch, 1926, 498; 1927, 332; 1929, 283.

An Australian specimen from the Johnston and Tiegs collection was identified by Aldrich as this species about 1921. It occurs in Queensland and New South Wales. The eye coloration shows black, but probably it is a blackish-red.

Genus *Metallea* v.d. Wulp.

v.d. Wulp, 1880, 174.—Malloch 1927, 329.

Both this genus and *Rhinia* contain species that hover in groups in the air, a feature that has allowed me to collect series that are undoubtedly conspecific. The species are very variable in coloration and can be identified by noting the fifth tergite of the female, the accessory plate on the male, and the fairly consistent hairing on the parafacials. The species of North Queensland and Western Australia have yet to be examined this way; the others are given below. In all cases the eyes in this genus are red.

Key to species of *Metallea*.

1. Fifth tergite on female membraneous. Accessory plate on male enlarged and angulated. Face conspicuously with dark hairs and the hairs on the cheek may be dark also	*incisuralis* Macquart.
Fifth tergite of the female chitinous. Accessory plates on male normal, not angulated	2
2. Accessory plates very broad. Face with some dark hairs ..	*nigribarbis* Aldrich.
Accessory plates normal in width. Face without dark hairs	*cuprea* Walker.

Metallea incisuralis Macquart.

Rhynchomyia incisuralis Macquart 1849, 241.

Metallea insularis Malloch 1927, 330.

The synonymy is new. The brush of the fifth sternite on the male is dense from the base to near the apex, and the eyes are separated by the width of two ocelli whenever the frons is not contracted. In average size the species is larger than the other two, reaching 12 mm., but not infrequently it is quite small, 6 mm. or less. It occurs in New South Wales and Queensland.

Metallea cuprea Walker.

Musca cuprea Walker 1856, 331.

Rhynchomyia gracilipalpis Macquart, 1855, 109.—Brauer, 1899, 514.

Rhynchomyia trigina Bigot, 1874, 242.—Brauer, 1899, 514.

Metallea illingworthi Malloch, 1927, 330; 1929, 283.—nec. Aldrich.

The synonymy is new. Information from Sir Guy Marshall, in a letter dated 15th September, 1920, places Walker's species as being near *Rhynchomyia*, and the description leaves no doubt concerning the identity of the species. Both Walker and Macquart described it from South Australia, from which State specimens are before me. Malloch may have confused two or more species under the name *illingworthi*, but this is certainly one of them.

The brush on the fifth sternite thins out on the apical half, leaving the basal half densely supplied with bristles, and the accessory plates are less stout than those of others seen by me. The eyes of the male are separated by the width of one ocellus only. A series captured hovering together at Goondiwindi (Queensland) shows very wide colour variations and no differences in terminalia. It also occurs in New South Wales, being very abundant wherever found.

Metallea nigribarbis Aldrich.

Aldrich 1926, 10.—Malloch 1927, 331.

This apparently less-common species is not represented from Victoria in the material before me, but I have it from New South Wales and Queensland. A series hovering together shows wide colour variations and no differences in terminalia. Malloch records it from Eidsvold (Q.), and females may be included under Aldrich's *illingworthi* type series. The species is very like *cuprea* and may be readily mistaken for it. Victoria to Queensland.

Metallea illingworthi Aldrich.

M. divisa (Walker).—Senior-White, 1924, 114; 1925, 90.—Bezzi, 1927, 234.—Limited to Australian specimens so named by both authors.

M. illingworthi Aldrich, 1926, 7.—nec. Malloch 1927.

Both Senior-White and Bezzi record *M. divisa* Walker from Australia, and judging from the illustration of the terminalia given by the former, I have seen no specimens to conform to it. Aldrich believed he had the same Queensland species as those two authors, and mentions the "thick" brush of spines, uniform in length on the fifth sternite, these spines thinning out into long bristles towards the apex. Malloch, on the other hand, draws terminalia, reputed by him to be from the same species, with the brush practically obsolete. Aldrich states that the eyes are separated by the width of two ocelli, a character I have not seen on the *cuprea* series, so it is possible that Aldrich's species is not before me, and Malloch's interpretation doubtless is mainly based on *M. cuprea* Walker. North Queensland.

Subfamily CHRYSOMYIINAE.

Australian species have been placed in several genera under this subfamily, but characters are not well established, standing as divisions no better than the similar divisions under *Calliphora,* nor is it clear where natural clefts occur worthy of generic consideration; therefore all forms in Australia are best relegated to the one genus. There are no satisfactory keys to species nor yet any comprehensive descriptions, and several species may yet prove to be complexes. The following notes give synonymy and biological data, the latter hitherto unpublished.

Genus *Chrysomyia* Desvoidy.

Chrysomyia Desvoidy 1830, 444.—Patton 1925, 405.—Bezzi 1927, 234.—Malloch 1927, 326.

Pycnosoma Brauer and Bergenstamm, 1894, 623.

Psilostoma Surcouf, 1914, 58.

Microcalliphora Townsend 1916, 618.—Aldrich 1925, 20.—Malloch 1927, 326.

Achoetandrus Bezzi, 1927, 235.

Eucompsomyia Malloch, 1927, 325.

All the terminalia I have seen in this genus have slender forceps fused together along the median line, and the accessory plates are also slender.

Chrysomyia incisuralis Macquart.

Ochromyia incisuralis Macquart 1849, 246.—Bigot 1877, 260. (*Somomyia*).—Surcouf 1914, 59. (*Psilostoma*).—Patton 1925, 409. (*Chrysomyia*).—Bezzi 1927, 235.—Malloch 1927, 327.

Before me there is only one pair definitely belonging to this species as it conforms to colour pattern on the type, illustrated by Surcouf. The specimens accessible to authors may not be conspecific, as they are darker and tend to differ in the distance between the eyes. This darker form occurs plentifully in rain-forest areas and a series from Mount Glorious (Q.) is before me. A specimen from Cairns is reported to have been

reared from cow-dung and was labelled "*Sternopterina gigas*" by W. W. Froggatt, and thus recorded by Johnston and Bancroft (Mem. Qu. Mus. vii. 1920, 12).

Hab.—New South Wales and Queensland.

Chrysomyia rufifacies Macquart.

Lucilia rufifacies Macquart 1843, 146.—Macquart 1849, 243. (*Calliphora*).—Froggatt 1918, 663 (larva). (*Pycnosoma*).—Bezzi 1927, 235. (*Chrysomyia*).—Fuller 1932, 94 (larvae).

Lucilia tasmanensis Macquart 1849, 249.—Aubertin 1933, 431.

?*Somomyia saffranea* Bigot 1877, 257.—Brauer 1899, 522.

?*Somomyia melanifera* Bigot 1877, 258.—Brauer 1899, 522.

Chrysomyia albiceps var. putoria Patton 1925, 409.

Chrysomyia albiceps Johnston and Hardy 1923, 33 (life cycle).—Malloch 1927, 327.—nec. Wiedemann.

Chrysomyia albiceps var rufifacies Patton 1934, 223 (fig. 4c, posterior spiracle of larva).

The power attributed to this species, of burrowing into the living flesh, proves to be erroneous; larvæ have been used in Brisbane surgically in the treatment of osteomylitis without inducing any trouble. The maggots are comparatively harmless and their predatory habits are greatly exaggerated. In experiments they breed together with maggots of *Lucilia* and *Calliphora* as long as the carrion is not advanced in decay, but a stage is reached when decay develops beyond that in which *Lucilia* and *Calliphora* are able to breed successfully and their maggots become weakened in consequence; this is the time when *Chrysomyia* maggots are liable to show their predacious powers. In a still further advanced state of decay *Ophyra* maggots thrive and, in their turn, prey on larvae that become weakened by disease. This simple series of progressive phenomena gives a better understanding of the relationship between the state of decay of carrion and the type of maggot fauna than has yet been published. Although *Chrysomyia* has been repeatedly reared on quite fresh carrion, the adults never seem to be drawn to it for oviposition under natural conditions, but will deposit on highly putrid carrion, whether other maggots be there or not. This has been shown by experiments in Brisbane.

Chrysomyia micropogon Bigot.

Somomyia micropogon Bigot 1888, 601.—Johnston and Hardy 1923, 33. (*Chrysomyia*).—Patton 1925, 406.—Bezzi 1927, 235.—Malloch 1927, 328.—Fuller 1932, 83 (larva).

Chrysomyia megacephala Bezzi 1927, 235.—Evidently referring to a form with large eye facets found in more northern parts of Australia and not certainly conspecific with the present species.

This fly does not seem to oviposit on sheep very often, but reports of its virulent nature suggest that the animal dies within two days of discovery. The reports need confirmation.

The sequence of attack on carrion is uncertain, but apparently the species oviposits earlier than *C. rufifacies*, but not as early as *Lucilia* and *Calliphora*. The smooth skinned larvae, when in a mass, appear to shiver, and can be easily detected at sight; they are not predacious.

Chrysomyia varipes Macquart.

Lucilia varipes Macquart 1849, 249.—Johnston and Hardy 1923, 33. (*Chrysomyia*).—Patton 1925, 410 (♀).—Bezzi 1927, 236. (*Microcalliphora*).—Malloch 1927, 326.—Fuller 1932, 86 (larvae).

Chrysomyia annulipes Patton 1925, 410 (♂).

A well-known small carrion fly in sheep country, with a tuberculated larva. The fly oviposits on carrion in a very advanced stage of decay.

Chrysomyia flavifrons Aldrich.

Microcalliphora flavifrons Aldrich 1925, 20 (♂).—Bezzi 1927, 236. —Malloch 1927, 326.

Chrysomyia fulvipes Patton 1925, 410 (♀).

Two females of the Illingworth material are before me.

Chrysomyia latifrons Malloch.

Eucompsomyia latifrons Malloch 1927, 326.

Two specimens come from the dense rain-forest of a gully near Mount Nebo road, Brisbane (part of the waterworks catchment area), so the species appears to be a rain-forest species of New South Wales and southern Queensland. The description is not very satisfactory and was based on a single male specimen, but it proves to be a valid species of *Chrysomyia*.

Subfamily CALLIPHORINAE.

Aphyssura new genus.

From a Western Australian specimen Malloch described characters conforming with the present genus and placed it in *Melinda*.* Also he gave it the name of a species which he previously described from New South Wales, *M. minuta* Mall. 1936. He omitted to give the characters in his first description that would indicate the genus. Evidently more than one species occurs, and my specimens are from Tasmania. I select for the genotype the Western Australian species, the only one adequately described for generic recognition.

The leading feature of this genus is the uncleft fifth sternite of the male, but otherwise the genus seems to be allied to *Pollenia*. This sternite has a spur-like process subapically placed and all the known specimens are small.

Type.—*Melinda minuta* Malloch. Western Australia.

* *Melinda* is part of the *Onesia* group of the genus *Calliphora*, differing by the absence of hairs on the squama, a character liable to occur on Australian *Onesia* species, and hence more applicable there than to *Aphyssura*, which is a genus more primitive than both *Calliphora* and *Pollenia*.

Genus *Pollenia* Desv.

Key to species of *Pollenia*.

1.	Light-coloured forms with tessellated abdomen; eyes of male separated by about the width of the ocellar tubercle. With very broad and elongated accessory plates and the aedeagus conspicuously elongate at apex	*flindersi* Hardy
	Dark forms with shorter aedeagus on all species examined	2
2.	Eyes on male separated by about the width of ocellar tubercle (N. S. Wales)	*sp.*
	Eyes on male separated by the width of two ocelli or less	3
3.	Male with hairs on the face entirely light yellow. Eyes separated by the width of one ocellus. Terminalia not examined	*tasmanensis* Macq.
	Hairs on face of the male dark at least on the upper half	4
4.	Eyes separated by the width of two ocelli. Accessory plate of medium width (Brisbane)	*sp.*
	Eyes separated by the width of one ocellus	5
5.	Accessory plate broad. Normally with one median bristle on the posterior side of the anterior tibiae	*calamisessa* Hardy
	Accessory plate of medium width. Normally with two median bristles on posterior side of anterior tibiae	*mortonensis* Macq.
	Accessory plate very narrow. Frons of male with abundant unusually long hairs	*hirticeps* Malloch

Pollenia tasmanensis Macquart.

P. tasmanensis Macq. 1849, 254.—Hardy 1926, 173.

P. stolida Malloch 1936, 21 (Sydney specimens only).

This synonymy is new. Macquart's record from Tasmania is evidently an error; it is only known to me from the Sydney district.

Pollenia calamisessa Hardy.

P. calamisessa Hardy 1932, 340.

P. stolida Malloch 1936, 21.—Typical form only.

The synonymy is new. Malloch's characters given for his typical form come well within variations of this widely dispersed species. It occurs from Victoria (F. Erasmus Wilson collection) to Queensland.

Pollenia mortonensis Macquart.

P. mortonensis Macquart 1854, 116.

P. nigrita Malloch 1936, 22.

From Tasmania to Queensland comes a species common in the southern areas, less plentiful around Brisbane, rather small, being from 5 to 7 mm. long, and to which the above synonymy is applicable.

Pollenia hirticeps Malloch.

P. hirticeps Mall. 1927, 318; and 1936, 21.

This is the common species of the Blue Mountains, New South Wales; from Adelaide comes an ally (unnamed) which has the normal short hairs on the frons.

Genus *Calliphora* Desvoidy.

Key to subgenera.

1.	Eyes hairy. Abdomen entirely ochraceous yellow	*Adichosia*
	Eyes bare	2
2.	Abdomen tesselated, being densely covered with a golden-brown pulverulent overlay	*Neopollenia*
	Abdomen otherwise coloured	3
3.	Abdomen yellow, with a metallic blue-green median stripe	*Proekon*
	Abdomen entirely blue-green or almost so	4
4.	Aedeagus with the struts free. Squama black-brown with a white edge	*Calliphora*
	Aedeagus with the struts fused with membrane to central tube throughout their length. Squama white, yellow, or dark, but never white-edged	*Onesia*

Key to species of subgenus *Onesia*.

1.	Large to average size, with forceps and accessory plates equally slender	2
	Accessory plates conspicuously broader than forceps, or if not then small species with a white pulverulent covering, and placed in couplet 9 below	4
2.	Eyes of male separated by the width of the ocellar tubercle	*robusta* Malloch
	Eyes of the male much narrower	3
3.	Eyes of the male separated by the width of two ocelli ..	*ruficornis* Walker
	Eyes of the male separated by the width of one ocellus ..	*pubescens* Macquart
4.	With lateral flanges developed to lie one beside each accessory plate, on one species triangular in shape, on the other twice as long as broad. Eyes separated by the width of the ocellar tubercle	*spp.*
	Without such flanges	5
5.	Accessory plates more than twice the width of the forceps, which are undulating in outline. Eyes separated by the width of two ocelli	? *clarki* Malloch
	Accessory plates normal, about twice or less the width of the forceps, which are not undulating in outline ..	6
6.	Struts of aedeagus fused together for practically their entire length, a character taken from figure, and not seen	*xanthocera* Malloch
	Struts of the aedeagus fused for half their length	7
7.	Accessory plates ending abruptly, more or less expanding at apex. Eyes separated by the width of ocellar tubercle. Abdomen blue-green or blue	*clausa* Macquart
	Accessory plates tapering at apex, not expanding apically	8
8.	Fourth tergite on both sexes with a dense pulverulent overlay hiding the ground colour. Eyes separated by the width of two ocelli	*dispar* Macquart
	Fourth tergite not so covered	9
9.	Abdomen black-green, heavily covered with a whitish pulverulent overlay, through which the ground colour shows. Eyes separated by the width of two ocelli ..	*minor* Malloch
	Abdomen blue-green, very lightly covered with a pulverulent overlay. Eyes separated by the width of one to two ocelli	*assimilis* Malloch

Calliphora dispar Macquart.

C. dispar Macquart 1846, 195.—Brauer 1899, 524. (*Somomyia*).—nec. Patton and others.

C. apicalis Malloch 1927, 312.—

The synonymy is new; both authors mention the pulverulent covering on the apical tergite, which marks the species. My specimens are from Tasmania, but is recorded from New South Wales.

Calliphora pubescens Macquart.

C. pubescens Macquart 1849, 242.—Johnston and Hardy 1922, 192 (in part).

C. dispar Patton 1925, 399.—Hardy 1926, 173.—Bezzi 1927, 243.—nec. Macquart, nec. Malloch.

?*C. australica* Malloch 1927, 314.

?*C. cyanescens* Loew.—Brauer and Bergenstamm 1891, 420.—Apparently a manuscript name only and may belong here, as the species seems to be represented in every collection.

The synonymy is new; in addition, this species is responsible for the record of *C. erythrocephala* from Brisbane, as the late E. W. Ferguson misnamed one in the Johnston and Tiegs collection. It is quite common in New South Wales and Queensland.

Calliphora robusta Malloch.

C. robusta Malloch 1927, 313.

From New South Wales and Queensland, but rare in the latter State.

Calliphora ruficornis Walker.

Musca ruficornis Walker 1857, 215.

Calliphora sp. Hardy 1926, 173.

Calliphora metallica Malloch 1927, 317.

The synonymy is new. I believe I am correct in placing here the name given by Malloch, although I have not seen the species from New South Wales. It is a common Tasmanian form which extends at least into Victoria.

Calliphora assimilis Malloch.

C. pubescens Johnston and Hardy 1922, 192 (in part).

C. assimilis Malloch 1927, 317.

C. dispar Malloch 1927, 312—nec. Macquart, nec. Patton.

The synonymy is new. Large specimens and the typical smaller ones show a wide distribution over Queensland; see note under *C. minor.*

Calliphora minor Malloch.

C. clausa Bezzi 1927, 245—nec. Macquart.

C. minor Malloch 1927, 314.

The synonymy is new. In addition, the drawings of terminalia given for *C. plebeia* Malloch suggest the same species, but is said to have enlarged eye-facets and the frons very narrow.

In Brisbane there are three small species commonly found frequenting the ground together. *C. minor* is heavily powdered on a black-green abdomen, and the aedeagus is relatively small. *C. assimilis,* larger in

average size, has the pulverulent covering less dense on a blue-green abdomen, and the aedeagus is relatively longer. *C. clausa* has a bluish abdomen with hardly any covering, which marks its identity under field conditions. Queensland; widely distributed.

Calliphora clausa Macquart.

C. clausa Macquart 1848, 55.—Brauer 1899, 524.—Hardy 1926, 172 —nec. Bezzi.

C. pusilla Macquart 1854, 130.—Brauer 1899, 524.

C. sp. Malloch 1927, 311.

C. accepta Malloch 1927, 316.—Fuller 1933, 325 (life history).

The synonymy is new. The closed and nearly closed fifth radial cell is not an uncommon feature of this species, and I have one male and a series of females from various States with the character. Bezzi records *clausa* from North Queensland, but the record evidently refers to *C. minor,* which also sometimes has the cell almost closed. Specimens are from Tasmania, South Australia, Victoria, New South Wales, and Queensland.

Calliphora clarki Malloch.

C. clarki Malloch 1927, 316.

I may be wrong in the identification of this species, the description of which agrees with a Queensland species before me and upon which I have based the characters given in the key; the type locality is Western Australia.

Calliphora xanthocera Malloch.

C. xanthocera Malloch 1927, 313.

If the struts of this species be correctly drawn, they must be fused along the median line to a greater extent than normal. I have not seen this character which is used in the key, but specimens from Donna Buang, a mountain near Melbourne, may be identical; the male lacks the aedeagus and cannot be identified with certainty. The type locality is Kosciusko.

Genus *Lucilia* Desvoidy.

Key to species of *Lucilia*.

1. With upstanding hairs above metathoracic spiracle; dorsocentral bristles arranged 2 :3 (*Hemipyrellia*) .. 2
   Without upstanding hairs above metathoracic spiracle; dorsocentral bristles arrange 3 :3 3
2. Face with a golden pulverulent covering. Thorax and abdomen partly yellow-orange. Lateral lobes (bordering genital cavity anteriorly to accessory plates) well developed and hairy .. .. *fergusoni* Patton
   Face with a silvery pulverulent covering. Thorax and abdomen without yellow-orange colouring. Lateral lobes restricted and very sparsely haired. Male with eyes conspicuously separated .. .. *ligurriens* Wiedemann
3. Subcostal sclerite with one or more upstanding bristles. Eyes on male closely approximate (*Lucilia*) 4
   Subcostal sclerite with only decumbent pubescence (*Phenicia*) 5

4. Anterior pair of postsutural acrostichals more advanced than second pair of postsutural dorsocentrals. Antennae orange	*flavicornis* Malloch
Anterior pair of postsutural acrostichals level with or slightly posterior to second pair of postsutural dorsocentrals. Female with two antero-dorsal bristles on middle tibiae	*papuensis* Macquart
5. Abdominal sternites of male with outstanding long hairs. Anterior femora normally with its colour metallic green	*cuprina* Wiedemann
Abdominal sternites of male less tufted in appearance, so that the hairs appear uniformly short. Anterior femora normally steel-blue in colour	*sericata* Meigen

DISTRIBUTION OF SPECIES OF LUCILIA.

L. cuprina Wied. 1830 (*Musca*) was described from China, but is supposed to be originally African, and has spread throughout the tropics.

L. sericata Meigen appears to be European and Asiatic and has spread throughout the more temperate areas. In Australia the distribution overlaps so that, as in Brisbane, wherever difficulty in distinguishing females on the accepted characters is evident, there is reason to suppose that a certain amount of interbreeding takes place. This would account for many unsatisfactory identifications in collections.

L. flavicornis Malloch 1927, is at present only known from Queensland and was reduced by Aubertin to a local variety of *L. porphyrina* Walker 1857, known from India, Japan, and Java.

L. papuensis Macquart 1843, is, I think, *L. tasmanensis* in Froggatt's Farmer's Bull. No. 95, 1915, p. 26 nec. Macquart. It is known from Queensland and New South Wales.

L. ligurriens Wiedemann 1830, is abundant in North Queensland, but also occurs in the South. Desvoidy's description of *L. germanica* reads like the same species, the locality given being "Nouvelle Hollande et de l'Isle de France." The latter is part of France, and so the species might be a *Phormia* as was suggested by Aubertin 1933. Nevertheless, Walker's identification from Adelaide can hardly be correct and possibly was based on *Chrysomyia rufifacies* Macq.

L. fergusoni Patton 1925, is common in the dense shore scrub and spreads to the open forest in the spring. It was reared by me from a pupa collected under a dead bird in the bush at Sunnybank several years ago. South Queensland and New South Wales.

Genus *Sarcophaga* Meigen.

The species in this genus form three main groups already dealt with in prior papers. The following notes bring the available information to date.

Evidently *S. omikron* J. and T. is mainly inhabiting the sheep country in all mainland States.

S. synia J. and T. has two allies, one found on the seashore, near Brisbane, the other reared from the Cossid moth pupa *Xyleutes* at the roots of *Bassia quinquecuspis* (the roly-poly) from Boggabilla, New South Wales, and on another occasion from Dirranbandi, Queensland. All three species belong to the *S. crinata*-group, which is limited to the Oriental and Australian regions.

It is still uncertain if *S. omega* J. and T. is conspecific with *S. knabi* Parker. The latter is an island species of the northern hemisphere, the former mainly inhabits the more arid sheep country of Queensland and New South Wales, but extending to Western and South Australia. There is no evidence yet to show a continuity in distribution as it appears to be absent from the equatorial belt and is rare in the coastal regions of Queensland. On the other hand, I am unable to find anything like a valid structural difference between the two.

S. gamma J. and T. proves to be *S. orchidea* Bott. as claimed by several authors, and its distribution includes the equatorial zone; some specimens are from the island of Manus.

Sarcophaga bancrofti J. and T.

S. bancrofti J. and T. 1921.—*S. fergusoni* J. and T. 1922, nec. Hardy 1936.

I have examined the Johnston and Tiegs types of both these, and have concluded they are conspecific. My identification of the latter in 1936 was based on a unnamed species. That new species was in the Johnston and Tiegs collection but left unnamed by them, and all the named specimens are *S. bancrofti*. Again, the subgeneric position may prove doubtful, and it may yet be moved from subgenus *Sarcophaga* and placed in *Parasarcophaga* as a decadent type. The female, now known, conforms with the predicted characters already given in key form by me (1936). The female allotype is from near Goondiwindi.

S. fergusonina n.sp.

S. ?fergusoni Hardy 1936, 95, nec. J. and T. 1922.

As my provisional identification of *S. fergusoni* has proved incorrect and the name sinks to synonymy, it is necessary now to erect a new name for the species I had then before me, and had based on two males from Goondiwindi, Queensland. A third specimen is in the Johnston and Tiegs collection, but poor in condition.

Helicobia australis J. and T.

In accordance with the classification by Rhodendorf (1937), this species should be referable to genus *Pierretia* Desvoidy 1863.

Tonnoir (1938) maintains *Helicobia* is a reasonable position for the species "in spite of discrepancies," but the relationships are bound up primarily with the Palaearctic fauna, not with that of North America to which *Helicobia* belongs; therefore several other names take precedence, reducing *Helicobia* to a synonym.

Tonnoir regards the lateral processes of the sheath as being part of the filaments, and hence he makes erroneous drawings of the aedeagus. The allotype female in the Australian Museum, Sydney, was overlooked by him, for he erected a second allotype.

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A SURVEY OF THE ECTOPARASITES OF DOGS IN BRISBANE, QUEENSLAND.

By F. H. S. Roberts, D.Sc., Animal Health Station, Yeerongpilly.

(*Read before the Royal Society of Queensland, 27th November, 1939.*)

In 1935 a check-list of the arthropod parasites occurring on domestic animals in Queensland was published (Roberts, 1935). Sixteen species were noted as having been recorded from the dog. Since then, 101 dogs in the Brisbane area have been examined. The incidence and prevalence of the various ectoparasites encountered are given here.

The animals examined comprised a wide range of breeds, and included house dogs, dogs used at the saleyards and abattoirs for droving stock, and dogs maintained by the Brisbane City Council for catching rats.

Each dog was dusted with derris powder and afterwards combed on to a sheet of paper. No claim is made that every ectoparasite was collected. The numbers secured, however, are considered to represent average samples of the populations present.

Siphonaptera.

Fleas were present on all dogs, a total of 3,358 specimens being collected. Five species were represented, namely, *Ctenocephalides felis* Bouché, *C. canis* Curtice, *Pulex irritans* L., *Nosopsyllus* (*Ceratophyllus*) *fasciatus* Bosc., and *Pygiopsylla congrua* J. and R.

Ctenocephalides canis Curtice.—The dog flea was taken from 88 animals (87·12 per cent.). It comprised 33·75 per cent. of the total fleas collected. Most of the specimens came from the saleyard and abattoir dogs.

Ctenocephalides felis Bouché.—Present on 95 dogs (94·06 per cent.), the number of cat fleas collected represented 64·9 per cent. of the total fleas examined.

The greater prevalence of *C. felis* in the Brisbane area is also borne out by the fact that of eighteen outbreaks of fleas in houses, stables, &c., recorded in this area during the past three years, fourteen were associated with this species. The remaining four outbreaks were divided evenly between *C. canis* and *P. irritans*.

Apparently *C. felis* is more common in warm climates than *C. canis*. Rothschild (1910) draws attention to this feature as does also Bedford (1932).

Pulex irritans L.—The human flea was found on only 12 dogs (11·9 per cent.). The total number of this species collected was 40, the highest number to be taken from any one animal being 12.

In the writer's experience, *P. irritans* is not a very common flea in Southern Queensland, being most frequent along the coast. Here it has been seen in outbreaks among pigs and poultry and is the species usually concerned in the infestation of seaside dwellings.

Pygiopsylla congrua J. and R.—Normally parasitic on the water rat, *Hydromys chrysogaster*, two specimens of this flea were taken from

a house dog. Subsequent enquiries showed that the dog was accustomed to visit river banks where this rodent abounds.

Nosopsyllus (*Ceratophyllus*) *fasciatus* Bosc.—A single specimen of this rat flea was found on a house dog. This species is regarded as being most prevalent in temperate climates and a search through the records of rat flea surveys in Queensland confirms this. Of 1,609 rat fleas examined by Burnett Ham (1907) in Brisbane only 0·37 per cent. were *N. fasciatus*. The species was not seen by Fielding (1927) among 536 rat fleas at Townsville and was also absent from 1,684 fleas examined by the Health Department of the Brisbane City Council in 1935.

It is interesting to note that the plague flea, *Xenopsylla cheopis*, which is common among rats in Brisbane, was not found on any dog, even among those employed for rat catching.

Another flea infesting dogs in Queensland, but not seen in this survey, is the red flea of the rabbit, *Echidnophaga myrmecobii*. It has been taken on dogs at Miles, Goondiwindi, and Charleville.

MALLOPHAGA AND SIPHUNCULATA.

Lice were found on eight animals (7·9 per cent.). The biting louse, *Trichodectes canis*, occurred as very light infestations on three dogs (2·97 per cent.). The sucking louse, *Linognathus setosus*, was found on four dogs (3·96 per cent.), and the kangaroo louse, *Heterodoxus longitarsus*, on one dog (0·99 per cent.).

The presence of *H. longitarsus* in Brisbane is of interest as previously it had been found only on dogs in Western Queensland. The infested animal was a Kelpie from the abattoirs.

IXODOIDEA.

Of the four species of ticks recorded from dogs in Queensland, only one was seen in the survey. The common brown dog tick, *Rhipicephalus sanguineus*, occurred on 15 dogs (14·85 per cent.).

SUMMARY.

The results of a survey of the ectoparasites of 101 dogs in the Brisbane area are summarised below in tabular form.

TABLE 1.

Species previously recorded.	Present in this Survey.	No. Dogs Infested.	Per Cent. Dogs Infested.
Ctenocephalides felis	+	95	94·06
Ctenocephalides canis	+	88	87·12
Pulex irritans	+	12	11·88
Nosopsyllus fasciatus	+	1	0·99
Trichodectes canis	+	3	2·97
Linognathus setosus	+	4	3·96
Heterodoxus longitarus	+	1	0·99
Rhipicephalus sanguineus	+	15	14·85
Boophilus australis	—	—	—
Ixodes holocyclus	—	—	—
Amblyomma triguttatum	—	—	—
Sarcoptes scabiei canis	—	—	—
Otodectes cynotis	—	—	—
Demodex canis	—	—	—
Trombicula hirsti	—	—	—
Leeuwenhoekia australiensis	—	—	—

Echidnophaga myrmecobii and *Pygiopsylla congrua* are recorded from the dog in Queensland for the first time.

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THE MIDDLE DEVONIAN RUGOSE CORALS OF QUEENSLAND, II.

THE SILVERWOOD-LUCKY VALLEY AREA.

By DOROTHY HILL, M.Sc., Ph.D.

(*Read before the Royal Society of Queensland, 27th November, 1939.*)

PLATES II. AND III.

SUMMARY.—The Rugose coral fauna of the Silverwood Series is described, and is considered to indicate a Lower Middle Devonian (Couvinian) age. The fauna is allied to that of the Nemingha limestone of New South Wales.

The four limestones from which Rugose corals are described below occur with others more marmorised in the Silverwood Series of the Darling Downs (Richards and Bryan, 1924, p. 58). The limestones form disconnected lenses almost at the top of the andesitic tuffs and lavas forming the lower part of the Silverwood series. They are all thought to be on the same horizon; immediately above them is a curious agglomeratic rock made up of fragments of these fossiliferous limestones in a groundmass of andesitic tuff, like the "agglomerate" associated with the Nemingha limestone of New South Wales. Six hundred feet above this agglomerate is a conglomerate, still in the andesitic tuff series. The upper part of the Silverwood series consists of banded cherts and shales.

The Silverwood limestone fauna contains the following Rugosa:—

Family ACANTHOPHYLLIDAE.

Acanthophyllum sp. cf. *mansfieldense* (Dun). Barnes Qy. (?).

Acanthophyllum sp. cf. *dianthus* (Goldfuss; Le Maître). Limestone Siding; portion 107, parish Wildash (Elbow Valley).

Acanthophyllum sp. Silverwood.

Family DISPHYLLIDAE.

Prismatophyllum latum sp. nov. Barnes Qy.

Prismatophyllum densum sp. nov. Lomas North.

Family FAVISTELLIDAE.

Fasciphyllum aff. *conglomeratum* (Schlüter). Limestone Siding.

Family MUCOPHYLLIDAE.

Pseudamplexus sp. Limestone Siding; Lomas North.

?Chlamydophyllum sp. Limestone Siding.

Family SPONGOPHYLLIDAE.

Spongophyllum halysitoides var. *minor* var. nov. Limestone Siding; Lomas North.

Xystriphyllum dunstani (Etheridge). Lucky Valley.

Xystriphyllum insigne sp. nov. Barnes Qy.; Limestone Siding; Lomas North.

Family STREPTELASMIDAE.

Streptelasma sp. Limestone Siding.

Age of the Fauna.—*Acanthophyllum* sp. cf. *mansfieldense* is closest to Lower Devonian forms, but bears some resemblance to Couvinian species. *A. dianthus* (Le Maître) occurs at the boundary between Coblenzian and Couvinian in France. *Prismatophyllum latum* is close to Couvinian forms from North America; *P. densum* is closest to the German Frasnian *P. ananas* Goldfuss, *Frech,* but has resemblances to the American Middle Devonian *P. sedgwicki* Ma, and to the Victorian (Lower Devonian?) *P. approximans* (Chapman). *Fasciphyllum conglomeratum* is characteristic of the Givetian of Germany. The Mucophyllidae resemble those of the Lower Devonian of Europe. *Spongophyllum halysitoides* occurs in the Nemingha and Moore Creek limestones of New South Wales. *Xystriphyllum dunstani* is characteristic of the Couvinian Clermont limestones in Queensland, and *X. insigne* occurs at Attunga, New South Wales, on a horizon regarded by Etheridge as almost certainly equivalent to the Moore Creek limestone. Streptelasmidae are known from the Ordovician to the Devonian. Thus the fauna would seem most reasonably placed as Couvinian, and is possibly Lower Couvinian. It shows no very close relation to any European or American fauna, however; *Spongophyllum halysitoides* occurs with *Pseudamplexus* sp. at Beedle's Freehold (por. 163, par. Nemingha), which is practically the type Nemingha limestone, and this is the closest comparison that can be made with other Australian faunas, as Richards and Bryan (1924, p. 99) have already pointed out.

Family ACANTHOPHYLLIDAE.

Acanthophyllidae Hill, 1939a, p. 220; 1939b, p. 56.

Genus *Acanthophyllum* Dybowski.

Acanthophyllum Dybowski, 1873, p. 339; 1874, p. 493.

Acanthophyllum; Hill, 1939a, p. 222; 1939b, p. 56.

Genolectotype (chosen Schlüter, 1889, p. 38); *Cyathophyllum heterophyllum* Edwards and Haime. Middle Devonian, Eifel.

Diagnosis.—Large, simple Rugosa with a wide dissepimentarium of small, highly-arched dissepiments, with shallowly concave, axially deepened tabulae, and with long but unequal major septa. The axial ends of the major septa are arranged in groups in the tabularium, and are straight, or curved vortically, the curvature differing in degree from group to group; the cardinal septum is typically short, and one septum, not a proto-septum, extends to the axis. The septa show different types of modification; they are frequently much dilated, either in the dissepimentarium, or more rarely in the tabularium, or in both; towards the periphery they may be thin and lined with lateral dissepiments; in the tabularium they are sometimes waved and carinate.

Range.—Fairly common in the Lower Devonian of Europe, and very common in the Middle Devonian of Europe. Lower and Middle Devonian of Australia.

Acanthophyllum sp. cf. *mansfieldense* (Dun).

(Plate II., figs. 1a, b.)

Material.—One specimen, F. 3412, University of Queensland Collection. Silverwood (probably from Barnes' Qy., Morgan Park).

Description.—A fragment 30 mm. in diameter and 5 mm. in length of the calical end of a corallite shows 20 major septa, 17 mm. long, extending unequally almost to the axis, alternating with 20 minor septa 14 mm. long. The septa of both orders are much dilated, in contact in a zone about 4 mm. wide, beginning 2 mm. outside the inner ends of the minor septa, but with narrow interseptal alleys between them outside this zone, in which lateral dissepiments are present, or inosculating dissepiments; in the peripheral regions the thick septa may be partly replaced by stacks of naic dissepiments. In the tabularium the septa are carinate. The tabular floors are concave, with a median notch, and the tabellae are not arched. The dissepimental floors representing old calical margins are flat peripherally and steeply inclined into the tabularium. The dissepiments are small, unequal, and rather elongate.

Remarks.—The fragment resembles the Coblenzian Acanthophyllids in the great thickness of the septa and their naic degeneration, but in having lateral dissepiments it is similar to the Couvinian forms called *Rhopalophyllum* by Wedekind. It appears closer to *A. mansfieldense* (Dun; Hill, 1939a, p. 223, pl. xv., figs. 1-3) from the Lower Devonian of Loyola, Victoria, than to any other figured *Acanthophyllum*, but identity is not complete.

Acanthophyllum sp. (Plate II., fig. 2.)

Cyathophyllum sp., Richards and Bryan, 1924, p. 97, Elbow Valley.

Material.—One fragment F 3413, University of Queensland Collection, embedded in matrix, from Limestone Siding. One thin section, F 3414, from por. 107, parish Wildash (Elbow Valley), Silverwood.

Diagnosis.—*Acanthophyllum* with a narrow peripheral stereozone, and with septa almost straight and equally dilated.

Description (of a transverse section).—At a diameter of 15 mm., just below the calice, 27 major septa alternate with 27 minor septa; at the periphery those of both orders are dilated so as to be in contact in a peripheral stereozone about 1 mm. wide; thence to their inner ends all the septa are rather dilated and almost straight, the dilatation being approximately equal; many are wavy or perhaps carinate, or with a slight swelling at the axial end; except for the two on either side of the counter septum, which are very long, the axial ends of the minor septa project just beyong the dissepimentarium, which is about 4 mm. wide. The axial ends of the major septa are long and unequal, but straight, and arranged in groups in the manner characteristic of the genus. The tabularium is about 6 mm. wide.

Remarks.—Only transverse sections are available. They have a very close resemblance to *Cyathophyllum dianthus* Goldfuss of Le Maître, 1934, p. 153, pl. v., figs. 13-14 (not necessarily of Goldfuss or any other author) from the Chaudefonds Limestone of France, which is regarded by Le Maître as the equivalent of the uppermost Coblenzian and lowest Couvinian of Germany and of the upper part of F_2 and G_1 in Bohemia.

Acanthophyllum sp. (Plate II., figs. 3a-c.)

Material.—F 3415, University of Queensland Collection. Silverwood.

Diagnosis.—*Acanthophyllum* in which the wavy septa are so dilated as to be in contact in the outer three-quarters of the dissepimentarium.

Description.—The corallum is large, and cylindrical or ceratoid. At a diameter of about 20 mm. there are 33 uncurved major septa interdigitating at the axis. alternating with minor septa which extend two-thirds of the way to the axis. The septa are so dilated as to be in contact to form a peripheral stereozone in the outer three-quarters of the dissepimentarium, and inside this they remain considerably dilated. They are wavy in transverse section. The tabulae are close, concave with a median notch, and incomplete. The dissepiments of the inner part of the dissepimentarium are inclined at about 45°.

Remarks.—This specimen might be the same species as the one described immediately above, but it shows very much greater septal dilatation. I know of no figure with which is could be closely compared; the dilatation is different from all other Acanthophyllids.

Family DISPHYLLIDAE.

Disphyllidae Hill, 1939a, p. 224.

Genus *Prismatophyllum* Simpson.

Prismatophyllum Simpson, 1900, p. 218.

Prismatophyllum; Lang and Smith, 1935, p. 558, *q.v.* for synonymy.

Prismatophyllum; Hill, 1939a, p. 229, *q.v.* for review of range and species.

Genotype.—*Prismatophyllum prisma* Lang and Smith, *loc. cit.* Lower Middle Devonian. Onondaga Limestone, Falls of Ohio, U.S.A.

Diagnosis.—Cerioid Rugose corals with septa which may or may not reach the axis; tabulae typically differentiated into a horizontally disposed axial series and an axially inclined periaxial series; and typically with numerous, small, globose dissepiments.

Range.—Lower, Middle, and Upper Devonian. For details, see Hill *loc. cit.*

Prismatophyllum latum sp. nov. (Plate II., figs. 4a, b.)

Phillipsastraea cf. *grandis* Dun, Richards and Bryan, 1924, p. 99, pl. xv., fig. 5. Barnes Qy. (near Morgan Park), Silverwood. Lower Middle Devonian.

Holotype.—F 3417, University of Queensland Collection, figured *loc. cit.*

Diagnosis.—*Prismatophyllum* with numerous septa, the major septa being but little longer than the minor; with a wide dissepimentarium and globose tabellae arranged in concave tabular floors.

Description.—The corallum is cerioid, one small fragment only of an apparently spreading corallum being known. The corallites are unequal, the largest being 15 mm. in diameter; the smaller corallites are found round the edges of the larger, as if by intermural increase. The walls dividing the corallites are thin, and difficult to see in the hand specimen. There are about 44 septa in the larger corallites, rather closely spaced and thinner near the periphery than near the tabularium,

and slightly carinate. The major septa are but little longer and thicker than the minor septa, extending just within the tabularium, which has about one third the diameter of the larger corallites, but more than this in smaller corallites. The tabular floors are slightly concave, and the tabellae are rather large and arched, and distant. The dissepiments are globose, fine and numerous, horizontally based or slightly inclined towards the periphery in the outer series, but steeply inclined towards the axis near the tabularium. They do not always extend completely across an interseptal loculus; many inosculate.

Remarks.—Of all the described species of *Prismatophyllum*, this species is closest to *P. chalkii* (Chapman) from the Lower or Middle Devonian limestone of Lilydale, Victoria, from which it differs only in having nearly twice the number of septa for any given diameter of corallite. It resembles also the American Couvinian *P. anna* Whitfield, Stewart (1938, pl. 9, figs. 11, 12) and *P. truncatum* Stewart (1938, pl. 10, figs.1, 2), but has thinner walls.

Prismatophyllum densum sp. nov. (Plate II., figs. 5a, b.)

Holotype (only specimen known).—F 3416, University of Queensland Collection. "Large Tryplasma Horizon," Silverwood—i.e., from either Morgan Park, Limestone Siding, or Lomas North; the matrix and preservation suggest to W. H. Bryan that it is from Lomas North. Couvinian, Lower Middle Devonian.

Diagnosis.—*Prismatophyllum* with clisioid axial structure and numerous very long carinate septa, not dilated at the inner edge of the dissepimentarium.

Description.—The holotype is a flat fragment 14 x 7 x 3 cm. Individual corallites are from 5 to 10 mm. in diameter, with an average of 8 mm. The corallites are polygonal with straight or gently curved walls, which may in places in the transverse sections, have a minor zig-zagging, the median dark line moving a little towards the axis of the corallite at the septal bases. Increase was not observed. The 19 or 20 very long major septa are waved, but their general course is straight from the wall to the axis, where they interdigitate, and sometimes twist slightly. The alternating minor septa are a little more than half as long as the major septa, and are also waved. All the septa are fairly thin, without any zonal thickening. There are six or seven series of dissepiments, all save the innermost being rather broadly and horizontally based; the inner series is more steeply inclined towards the axis. The tabularium is about one-third the width of the corallite, and has two series of tabellae, the outer series of horizontally disposed but concave plates, and the inner of convex, dissepiment-like plates arranged to form an axial dome.

Remarks.—Only three other species of *Prismatophyllum* have a clisioid axial structure—the Victorian *P. approximans* (Chapman, 1914, pl. xlvii., figs. 5, 6) from the Thomson River, the American Middle Devonian *P. sedgwicki* (Edwards and Haime, Ma, 1937, pl. iii., fig. 3), and the German Frasnian *P. ananas* (Goldfuss, Frech, 1885, pl. iii., fig. 14). *P. densum* differs from *approximans* in not having the septa dilated to a spindle section, and in having the outer series of taballae horizontal instead of inclined. It differs from *sedgwicki* Ma similarly, and in the greater length of the septa; from *ananas* Frech it differs only in the greater number and density of the septa and in the slightly greater size of the individual corallites. It is thus closest to the Frasnian *ananas*.

Family FAVISTELLIDAE (or COLUMNARIIDAE).

Typical Genus:—*Favistella* Hall, 1847.

Cerioid or sub-phaceloid Rugosa with complete tabulae and short minor septa, sometimes with a single, impersistent series of elongate, and usually vertically inclined dissepiments between the septa.

Range.—The family is known from the Upper Ordovician of Europe and America, the Silurian of Europe, and the Devonian (but not the Upper Devonian) of Europe and Australia.

Remarks.—The group here considered has already been discussed in some detail (Hill, 1939a, p. 240) when it was thought doubtful that the genotype of *Columnaria* (*C. sulcata* Goldfuss) from the Middle Devonian of Germany belonged to the same genus as the species *C. alveolata* Goldfuss from the Ordovician of America, on which most authors have interpreted *Columnaria* Goldfuss, and which is synonymous with *Favistella stellata* Hall, 1847, the genotype of *Favistella.* Smith is still of the opinion (*in litt.*) that *sulcata* is of the same genus as *alveolata*; but Weissermel (*in litt.*) considers, like myself, that *sulcata* is a Disphyllid. The matter is still in abeyance, and while the family relation of *sulcata* is in doubt, it seems best to take *Favistella,* on the nature of whose type we all agree, as the type genus for the family around *alveolata* Goldfuss. For the genera considered to belong to this family, see Hill *loc. cit.*

Genus *Fasciphyllum* Schlüter.

Fasciphyllum Schlüter, 1885, p. 52; 1889, p. 305 (47).

Fasciphyllum; Lang and Smith, 1935, p. 548.

Genotype (by designation).—"*Fascicularia?*" *conglomerata* Schlüter, 1880, p. 147, Givetian, Eifel, Germany.

Diagnosis.—Phaceloid Rugosa; the slender corallites have a narrow stereozone, a single series of elongate dissepiments between the long major and short minor septa, and distant, complete, sagging tabulae.

Range.—Lower Devonian of Eastern Alps; Middle Devonian of the Eifel and Queensland.

Remarks.—The genus has been discussed by Hill (1939a, p. 241). The large dissepiments suggest relation to the Spongophyllidae, but in the Favistellidae dissepiments arise between the septa, and do not cause the septa to become discontinuous, as in the Spongophyllidae.

Fasciphyllum aff. *conglomeratum* (Schlüter).

(Plate II., figs. 6a-c.)

"*Fascicularia?*" *conglomerata* Schlüter, 1880, p. 147; 1881, p. 220, p. ix., figrs. 1-4. Givetian, Eifel, Germany.

Fasciphyllum conglomeratum Schlüter, 1885b, p. 52.

Holotype.—Schlüter's types are probably at Bonn. The diagnosis given below is based on his figures *loc. cit.*

Diagnosis (for *conglomeratum* Schlüter).—*Fasciphyllum* with corallites about 3 mm. in diameter.

Description (of Silverwood specimen, from Limestone Siding, F 3418, University of Queensland Collection).—The specimen is a small

fragment 5·5 x 3·5 x 1·5 cm., in a re-crystallised, fine-grained, white limestone. The corallum is phaceloid, the corallites varying in diameter from 2 to 3·5 mm., and in distance apart from 0 to 3 mm. The twelve major septa extend from the wall to the axis, where in some corallites they appear to touch; the minor septa are short. The septa never show discontinuity; they are all stout, and their bases are expanded to form a narrow peripheral stereozone. There is a single series of dissepiments, the bases of the more elongate being more steeply inclined than the others. In one or two places there may have been a second but incomplete series of dissepiments. The tabulae are complete, sagging, and rather distant.

Remarks.—The resemblance between the Silverwood specimen and the German species is very striking, but its preservation is so poor that a direct equation to the German form is too great an assumption. According to Lang and Smith (1935, p. 548), *F. conglomeratum* probably reaches its maximum in the *Stringocephalus* limestone, but apparently occurs also in the Crinoid Shales. Kayser (1923, p. 198) regards the latter as the base of the Givetian in Germany, and the former as its main development. The Lower Devonian species *F. syringoporoides* (Charlesworth, 1914, p. 366, pl. xxxi., fig. 1) from the Alps has corallites only 1 mm. in diameter.

Family MUCOPHYLLIDAE.

Typical Genus: *Mucophyllum* Etheridge.

Simple Rugose corals with the approximately equal compact major and minor septa dilated and in contact so that dissepiments are entirely suppressed, and with complete and distant tabulae.

Range.—Ludlovian of Gotland and New South Wales; Lower Devonian of Europe; and Middle Devonian of Germany.

Remarks.—The other genera placed in this family are *Pseudamplexus* Weissermel and those listed below with references and genotypes, as possible synonyms of *Pseudamplexus*. They are the Ludlovian *Pseudomphyma* of Gotland and *Mucophyllum* of New South Wales; the Lower Devonian *Pseudamplexus* and its synonym *Pselophyllum* of Europe; and the Middle Devonian *Aspasmophyllum* of Germany. All of these forms have major septa very little longer than the minor septa; *Mucophyllum* and *Aspasmophyllum* are patellate forms, as is one species of *Pseudomphyma,* but most of the forms placed by Wedekind in *Pseudomphyma* and all *Pseudamplexus* are turbinate to cylindrical. The family as thus understood is a small one; in fact, examination of the type specimens may show that all the genera are synonymous.

Its relations to the other Silurian and Devonian groups characterised by a wide peripheral stereozone are not yet clear in all cases. The Silurian genera *Gyalophyllum* Wedekind (1927) and *Zelophyllum* Wedekind (1927) both have a stereozone of holacanthine septa set in lamellar sclerenchyme (Hill, 1936) and are, therefore, related to *Rhabdocyclus* Lang and Smith (1939, p. 152, *nom. nov.* for *Acanthocyclus* Dybowski) and *Tryplasma;* but it is possible that by a closer packing of the trabeculae, the Mucophyllidae, with compact lamellar septa, have arisen from the Rhabdocyclidae with rhabdacanthine septa.

The Wenlock "*Chonophyllum*" *patellatum* (Schlotheim) of Europe and the Wenlock and Ludlow *Kodonophyllum* Wedekind of Europe and

the Ludlow compound *Circophyllum* Lang and Smith (1939, p. 153, *nom. nov.* for *Rhysodes* Smith and Tremberth, 1927) of Gotland all have long major septa, those of the first and third meeting at the axis to form an axial structure; these three may be related to the Mucophyllidae, as their septal structure is very similar; but Lang and Smith have considered *Kodonophyllum* to be derived from *Xylodes*, by dilatation of the septa. Other Silurian genera, with narrow peripheral stereozones and long minor septa, are not here considered in relation to the Mucophyllidae.

Chonophyllum Edwards and Haime from the Ludlovian of Gotland (genotype *Chonophyllum perfoliatum* Goldfuss, with which *Omphyma flabellata* Wedekind, 1927, pl. 17, figs. 3, 4, also from the Ludlovian of Gotland, is probably synonymous) differs from the Mucophyllidae in the great length of the septa and in the very wide stereozone being cellular by reason of the incomplete dilatation of the septa. It has no axial structure.

The French Lower Devonian *Briantia* Barrois has long minor septa and closely resembles the Silurian *Kodonophyllum*. *Chlamydophyllum* Pocta from the Lower Devonian of Bohemia has amplexoid major septa; i.e., above the tabulae they are long and meet at the axis, but between the tabulae they shorten. It is possibly related to the Mucophyllidae. The "Chonophylla" described from Bohemia by Pocta appear to include more than one genus, but in all, the dilated septa are broken down so that spaces occur in them, much as in *Chonophyllum* s.s.

"*Chonophyllum perfoliatum*" auct. non Goldfuss from the Frasnian of France and the Giveto-Frasnian of England has a small continuous axial structure, but septa like the Silurian *Chonophyllum*.

In *Amplexus* (*Coelophyllum*) *eurycalyx* Weissermel (1894, p. 634, Diluvial of Germany), *Tryplasma liliiforme* Etheridge (1907, p. 95, Ludlovian of New South Wales), and *Pseudomphyma expansa* Wedekind (Soshkina, 1937, p. 56, from the Middle Ludlow of the Urals) there is a group with an expanded calical rim, wide but not very thick, which may well be related to the Mucophyllidae. *Mucophyllum* differs from it only in the much greater thickness of the expanded calical rim. Etheridge, by placing the New South Wales species in *Tryplasma* has suggested the relations of the group to be with that family; but in the septa the trabeculae are closely packed as in the Mucophyllidae. Weissermel, by placing his species in *Amplexus* (*Coelophyllum*), suggested a relation to the German Middle Devonian *Amplexus*-like group later called *Cyathopaedium* by Schlüter (1889, p. 5) with which the American Guelph (Lower Ludlow) *Pycnostylus* Whiteaves (1884, p. 2) may be synonymous. I have seen no European specimens of this group, but think that some of the other Australian Ludlovian and Devonian species placed by Etheridge in *Tryplasma* may belong to it.

Genus *Pseudamplexus* Weissermel.

Pseudamplexus Weissermel, 1897, p. 878.

? *Aspasmophyllum* F. Romer, 1880, p. 184. Monotype, *Aspasmophyllum crinophilum* Romer, 1880, *id.* Middle Devonian, possibly Crinoid shales at the base of the Givetian, Gerolstein, the Eifel.

? *Mucophyllum* Etheridge, 1894, p. 11. Monotype, *Mucophyllum crateroides*, Etheridge, *id.*, pls. iii., iv., Upper Silurian, Yass, N.S.W.

Pselophyllum Pocta, 1902, p. 82. Genosyntypes (from Lower Devonian, F_2, Koneprus): *Pselophyllum obesum* Barrande MS in Pocta *id.*, *Pselophyllum bohemicum* Barrande in Pocta *id.*, and *Pselophyllum vestitum* Barrande in Pocta *id.* Genolectotype, here chosen, *Pselophyllum bohemicum.*

? *Pseudomphyma* Wedekind, 1927. p. 34, p. 37. Genotype by designation *Pseudomphyma profunda* Wedekind *id.*, pl. 6, figs. 8-10, Upper Silurian (Lidlovian), Storungs, Gotland.

Genotype (by monotypy).—*Zaphrentis Ligeriensis* Barrois, 1889, p. 52, pl. iii., fig. 1. Lower Devonian. Erbray, France.

Diagnosis.—Large simple Rugosa with sub-equal short major and minor septa dilated and in contact to form a peripheral stereozone in lieu of a dissepimentarium, and with a wide tabularium of distant, horizontal, complete tabulae.

Remarks.—Weissermel's genus *Pseudamplexus* was overlooked until he himself referred to it (1939) in discussing forms like *Pselophyllum*, when he proposed, in view of his original definition, that *Pseudamplexus* should be set aside until *Amplexus* was proved polyphyletic, one group coming from *Columnaria* and another from *Zaphrentis*, both by the operation of the amplexoid trend; *Pseudamplexus* could then be used for the latter group. But he named a single species *Zaphrentis ligeriensis*, as belonging to the genus, giving its bibliographic reference; according to my reading of the Rules of Nomenclature, this makes *Pseudamplexus* a valid genus—a designated actual species is the ultimate reference for a genus, not an author's definition of a genus. *Zaphrentis ligeriensis* is congeneric if not conspecific with *Pselophyllum bohemicum*, the genolectotype of *Pselophyllum*. It appears therefore that *Pselophyllum* must be retired to the synonymy of *Pseudamplexus.*

The genera here listed as possible synonyms have been considered in the remarks on the family. The species here regarded as of the genus are, in addition to the genotype:—Pocta's three Lower Devonian syntypes of *Pselophyllum*; *Aspasmophyllum ligeriensis* (Barrois), Charlesworth (1914, p. 352, pl. xxx., fig. 1) from the Lower Devonian of the Eastern Alps; *Tryplasma princeps* Etheridge (1907, p. 97) from the Upper Silurian or Lower Devonian of Molong District, New South Wales; and the ?Couvinian specimen from Silverwood described below.

Septal Structure.—From a study of Pocta's figures, and thin sections of the Silverwood form, I conclude that in this genus the septa consist of a single series of rhabdacanths (Hill, 1936) much expanded laterally and very closely placed, fine lamellar sclerenchyme being interwoven with the "rods" of the rhabdacanths. *Pseudamplexus* thus shares rhabdacanths with the Rhabdocyclidae; but holacanths have not been observed, and the lamellar sclerenchyme is not continuous from one septum to the next, as in the Rhabdocyclidae. The structure of the septa in "*Chonophyllum*" *patellatum* and in *Kodonophyllum* is very similar; but there appears to be a slightly different grouping of the "rods" in the rhabdacanths.

Pseudamplexus sp. (Plate III., figs. 1a-c.)

Tryplasma princeps; Richards and Bryan, 1924, p. 98, pl. xv., figs. 3, 4, Middle Devonian, Silverwood, Queensland.

non Tryplasma princeps Etheridge, 1907, p. 97, Upper Silurian (or Lower Devonian) of Molong District, N.S.W.

Material.—F 3419-20, University of Queensland Collection. Lomas North, Silverwood, near Warwick, Queensland.

Diagnosis.—Large trochoid *Pseudamplexus* with septa up to 10 mm. long.

Description.—Only fragments of coralla are known, usually crossed by many small faults. The specimen (F 3419) figured by Richards and Bryan is a truncated and vertically broken fragment 30 mm. in diameter at its broken base, and 60 mm. at least at its obliquely cut upper surface, which is 50 mm. from the lower. It has a large rootlet 5 mm. wide, broken off at 20 mm. from its origin, with an axial cavity, and walls about 2 mm. thick. The calice is not known, nor the apex, nor the epitheca.

The septa are 8 mm. long in the upper section of this fragment, and major septa cannot be distinguished from minor septa; the septa are very thick, 4 in a space of 10 mm., and 28 in less than a half section of the corallum; about 2 mm. of their axial ends are free laterally and there is no indication that the inner margins are denticulate or acanthine. Their nature in the early part of the corallite and in the calice is unknown. They consist of a single series of almost horizontal uncurved trabeculae, directed upwards at a very slight angle. The trabeculae are about 0·5 mm. from the lower inclined surface to the upper, and extend laterally to the sides of the septa. Each appears to consist of rather sparsely developed bundles of fibres, each bundle like a rod issuing obliquely upwards from the axis of the trabecula, but quickly curving outwards and proceeding to the side of the septum so that the longest portion is normal to the axis of the trabecula. Connecting these "rods" in the body of the septum is finely lamellar sclerenchyme, curving among the rods at right angles to the course of the rods. In some weathered surfaces this lamellation is more distinct at regular and somewhat larger intervals, and gives the repeatedly scalloped appearance so clearly shown in Pocta's (1902) figures of *Pselophyllum*. The lamellar sclerenchyme is not continuous from septum to septum; the lamellation runs from the axial parts of the septa back towards the peripheral parts, almost to the epitheca, before turning sharply towards the corresponding lamellae of a neighbouring septum (as in Pocta, 1902, pl. 109, figs. 1, 2). The peripheral stereozone dilates slightly but gradually toward the upper part of the corallum. The tabulae are complete, horizontal, and somewhat irregular in distance apart, varying from 2 to 4 in 5 mm. They are somewhat dilated.

Remarks.—As nothing is known of the calical characters or the apical parts of this form, it is thought better not to give it a specific name. The lamellation seen in the septa is thought to be growth lamellation, and its structure and origin is believed to be that described by Hill (1936) in *Rhabdocyclus*. Though in the Rhabdocyclidae and the Mucophyllidae the septa are rhabdacanthine, in the Mucophyllidae as opposed to the Rhabdocyclidae, the rhabdocanths are extremely close together, and the lamellar sclerenchyme is not continuous from septum to septum.

A fragment (F 3421) from Limestone Siding, figured by Richards and Bryan (1924, pl. xv., fig. 1) as an undescribed Rugose coral with features common to *Tryplasma* and *Mucophyllum*, may be a portion of the calice of our *Pseudamplexus* sp. It has the same septal structure, but the calical rim seems to be very expanded, and the tabularium is probably much narrower than in our *Pesudamplexus* sp., so that the fragment may represent a second species.

A specimen in the Australian Museum from Beedle's Freehold (por. 163, par. Nemingha), Moonbi, New South Wales—i.e., from the type locality for the Middle Devonian Nemingha Limestone—may well be our species, but it is a calical fragment only, and indicates that there was a sudden expansion in diameter of the corallite at the base of the calice, although the later increase in diameter of the calice was at approximately the same rate as that of the corallum previously. This type of calice was figured for *P. ligeriensis* by Barrois (1889, pl. 3, fig. 1). A second specimen in the Australian Museum, F 741, also from the Nemingha Limestone, is *Pseudamplexus* sp., but it differs from the Silverwood form in being sub-cylindrical. The specimen from the Moore Creek limestone of Attunga, mentioned by Etheridge as *Tryplasma princeps,* has not been traced, but its affinities may be with *Pseudamplexus.*

The Silverwood form differs from the Lower Devonian Bohemian *P. bohemicus* and *P. vestitum* and the Lower Devonian Alpine "*Aspasmophyllum ligeriensis*" in the smaller width of its peripheral stereozone, and from the Lower Devonian Bohemian *P. obesum* in the greater width of its stereozone. In shape of corallum it closely resembles *P. obesum.* It differs from the French Lower Devonian *P. ligeriensis* (Barrois) in its greater size and more expanding shape.

Richards and Bryan identified the Silverwood form with *Tryplasma princeps* Etheridge from the Upper Silurian or Lower Devonian of the Molong District, New South Wales; but while *princeps* is probably *Pseudamplexus* it has a much narrower stereozone than the Silverwood form, and a more cylindrical habit.

Genus CHLAMYDOPHYLLUM Pocta.

Chlamydophyllum **Pocta, 1902, p. 134.**

Genotype (by monotypy).—*Chlamydophyllum obscurum* Pocta, *id.,* pl. 114, fig. 2; pl. 115, figs. 2-5. Lower Devonian, F_2, Koneprus, Bohemia.

Diagnosis.—Simple Rugosa, trochoid at first, later cylindrical with much rejuvenescence, and swollen distally; calice funnel-shaped; with a wide peripheral stereozone formed by lateral contact of the dilated major and minor septa; in the tabularium the axial ends of the major septa are unequal, usually long, straight or of irregular curvature, and many have clubbed ends; they may unite at the axis in the proximal parts of the corallum, and on the surfaces of the tabulae in the distal parts, being then withdrawn between tabulae; the tabulae are complete and horizontal; the cardinal fossula is clearly visible by the pinnate arrangement of the septa in the tabularium.

Remarks.—Pocta states (p. 136) that the septa of the genotype consist of vertical lamellae parallel to their surfaces. Possibly this is a similar growth lamination to that described above for *Pseudamplexus.* Mlle. Le Maître (1934, p. 160) has identified with Pocta's species a specimen from the Upper Coblenzian or Lower Couvinian of Chaudefonds, France, which has major septa with ends inrolled at the axis, incomplete, domed tabellae, and a septal structure quite similar to that of *Pseudamplexus.* Further illustrations of topotypes are necessary to a complete understanding of the genus. *Zaphrentis cornuvaccinum* Penecke (1894, p. 593, pl. vii., figs. 10-12) which is the commonest species of the *barrandei*-Limestone (Upper Coblenzian) of Graz, may

be generically related to *Chlamydophyllum obscurum* or to the specimen from Silverwood described below.

The genus is here considered as a possible member of the Mucophyllidae, as it has the shape, peripheral stereozone, and septal structure of that family; but it differs from the members of the family (*s.s.*) in that its septa are amplexoid (Hill, 1935, p. 502) and not confined to the peripheral stereozone.

? *Chlamydophyllum* sp. (Plate III., figs. 2a-d.)

Material.—A single specimen from Silverwood, probably from Limestone Siding. F 3422, University of Queensland Collection.

Description.—A specimen in a rock mass is assumed, from the fragments into which it was broken, to have been turbinate, with an everted calicular platform round a calicular pit. The diameter at the platform is about 50 mm., and there are about 70 septa. Outside the tabularium the septa are so dilated as to be in contact to form a peripheral stereozone, whose width increases with the height of the corallum, forming the platform 10 or 12 mm. wide. A section taken near the floor of the calice shows alternating major and minor septa; the inner third or half of the minor septa is less dilated than the rest, and free laterally; the major septa are unequal, attaining almost to the axis, irregular in curvature, and frequently somewhat swollen at their axial ends. The septa are rhabdacanthine, with very close rhabdacanths, and a rich development of "rods," so that lamellar sclerenchyme does not appear important; in transverse section of the corallum the growth lamellae curve round the inner ends of the septa, and run back towards the epitheca almost parallel with the median plane of the septa. The "rods" curve outwards rapidly, and for a considerable part of their length are directed normally to the surfaces of the septa. A fossula is not distinguishable in this incomplete section. A vertical section shows the distant, flat, somewhat dilated tabulae, whose upper surfaces carry sections of the dilated septa. They appear to have down-turned margins.

Remarks.—The determination of this specimen is doubtful, both because of the poverty of material and the uncertainty regarding the characters of *Chlamydophyllum*. Our specimen is not known to form an axial structure by its conjoined septal ends, as in the genotype; but it is incomplete, the apical portion being unknown. The length of the septa precludes our placing it in *Pseudamplexus*, although its shape, stereozone, and septal structure is similar.

Family SPONGOPHYLLIDAE.

See Hill, 1939b, p. 58.

Genus *Spongophyllum* Edwards and Haime.

Spongophyllum Edwards and Haime, 1851, p. 425.

Spongophyllum; Jones, 1929, p. 88, *q.v.* for comparison with *Endophyllum*.

Spongophyllum; Hill, 1939b, p. 58, *q.v.* for review of genus.

Genotype (by monotypy).—*Spongophyllum sedgwicki* Edwards and Haime, *loc. cit.*; 1853, p. 242, pl. lvi., fig. 2, 2a-e. [Middle] Devonian [or Frasnian], Torquay.

Diagnosis.—Cerioid Rugosa in which the tabularium is narrow and the tabulae close and slightly concave, the minor septa are degenerate,

and lonsdaleoid dissepiments may be developed in an irregular peripheral zone when the major septa are discontinuous.

Remarks.—The genus as interpreted by Hill *loc. cit.* contains five Upper Silurian and six Middle Devonian species.

Spongophyllum halysitoides Etheridge.

Spongophyllum halysitoides Etheridge, 1918, p. 49, pl. vii.
Spongophyllum halysitoides; Jones, 1932, p. 56.

Holotype (by monotypy).—In the Australian Museum Collection. Nemingha Limestone, road near Beedle's Farm, Moonbi, co. Inglis, New South Wales. Upper Middle Devonian.

Diagnosis.—*Spongophyllum* in which septa are frequently entirely absent, even from the tabularium.

Remarks.—This species is known from Moore Creek, near Tamworth, New South Wales (F 6760, Australian Museum Collection), in addition to the type locality. Its corallites are 4-6 mm. in diameter, and in many the major septa are absent as well as the minor, so that the interrupted sections of dissepiments and tabulae give the corallites the appearance of a rose, in transverse section. The septal bases of neighbouring corallites are usually opposite, and are somewhat swollen, so that in sections of the walls a *Halysites* appearance is obtained.

Spongophyllum halysitoides var. *minor,* var. nov.

(Plate III., figs. 3a, b.)

Spongophyllum cf. *halysitoides* Etheridge, Richards and Bryan, 1924, p. 99, pl. xvii., figs. 1, 2; Limestone Siding and Lomas North, near Silverwood, Queensland.
Spongophyllum halysitoides; Jones, 1932, p. 56, *partim;* i.e., Silverwood specimens, text-fig. 2.

Holotype.—F 3423, University of Queensland Collection. Limestone Siding, near Silverwood. Couvinian, Lower Middle Devonian. Figured herein, and Richards and Bryan *loc. cit.*

Diagnosis.—*Spongophyllum halysitoides* with small corallites from 2 to 4 mm. in diameter.

Description.—The external form of the cerioid corallum is unknown, only weathered sections of fragments having been collected. Individual corallites are from 2 to 4 mm. in diameter, usually 3 mm., and are 5 or 6 sided, the sides being straight or but slightly curved in transverse section. The septal bases are less frequently opposite than in *halysitoides* itself, so that the walls are slightly wavy rather than halysitoid. There are 22-26 septal bases in each corallite; in some corallites no other trace of septa can be seen; but frequently 12 or 13 more or less discontinuous major septa may be traced from the wall almost to the axis. Minor septa have been observed only as septal bases. Each septal base is swollen and in contact with its neighbour, the greatest dilatation being in its median part. The tabularium is narrow—only about 0·5 mm. in diameter—and contains complete, slightly concave tabulae, about 10 in a space of 5 mm. The dissepiments are very large, their angle of inclination increasing towards the axis; one or two series only are developed.

Remarks.—The difference in size between the two Silverwood specimens described as the variety *minor* and the two Tamworth specimens is

constant, the corallites of the Silverwood forms being just over half as large. Further, in the Silverwood specimens the septal bases of neighbouring corallites are more often alternate than opposite. The tabularium of the Tamworth type has nearly one-third the diameter of the corallites. It is here thought that the characters of the Silverwood specimens indicate that they are a variety of the Tamworth type.

Spongophyllum forms two groups in time—one Upper Silurian and the other Middle Devonian—but neither possesses a distinctive feature. *Halysitoides* and its variety *minor* form a special group, being the only forms known to show complete disappearance of the septa so frequently that such absence is a diagnostic character. The Tamworth limestones bearing *S. halysitoides* are probably Givetian. The variety occurs in the Lomas North Limestone, Silverwood (F 3424; University of Queensland Collection) in addition to the type locality.

Genus *Xystriphyllum* Hill.

Xystriphyllum Hill, 1939b, p. 62.

Genotype (by designation).—*Cyathophyllum dunstani* Etheridge, 1911, p. 3, pl. A, figs. 1, 2. Douglas Creek, Clermont, Queensland. Couvinian, Lower Middle Devonian.

Diagnosis.—Cerioid Rugose corals with long major septa and well-developed minor septa, and with close, concave tabulae, and globose dissepiments.

Remarks.—See Hill *loc. cit.* for the four species previously included in this Lower and Middle Devonian genus. The association of *X. dunstani* with *Spongophyllum cyathophylloides* Etheridge, two species of similar dimensions, was there remarked; and the similar association at Silverwood of *Spongophyllum halysitoides* var. *minor* with a new species of *Xystriphyllum* described below gives rise to the speculation that *Spongophyllum* may be a genomorph of *Xystriphyllum* formed by the poor development of the septa in the dissepimentarium.

Xystriphyllum dunstani (Etheridge). (Plate III., figs. 4a, b.)

Cyathophyllum dunstani Etheridge, 1911, p. 3, pl. A, figs. 1, 2.

Xystriphyllum dunstani; Hill, 1939b, p. 62.

Lectotype (chosen Hill, *id*).—Cl. 6, Geological Survey of Queensland Collection. Couvinian. Douglas Creek, Clermont.

Diagnosis.—*Xystriphyllum* with long, unequal major septa interdigitating in the tabularium; in some corallites the minor septa may be lost and lonsdaleoid dissepiments may arise.

Remarks.—A specimen in the Collection of the Geological Survey of Queensland from Mullin's Paddock, Lucky Valley, Silverwood, although much re-crystallised, is placed without hesitation in this species, which has recently been fully described in these proceedings. The corallites are from 6-8 mm. in average diameter, and 17 or 18 long major septa which interdigitate at the axis alternate with minor septa nearly three-quarters as long. The walls are thick, and the outermost series of dissepiments is larger and more globose than the rest. There are indications of lonsdaleoid dissepiments, but the difference in thickness between major and minor septa is not so great as in topotypes. The Clermont locality is probably Upper Couvinian.

Xystriphyllum insigne sp. nov. (Plate III., figs. 5a, b.)

Holotype.—F 3425, University of Queensland Collection. Limestone Siding, Silverwood, Queensland. Couvinian, Lower Middle Devonian.

Diagnosis.—*Xystriphyllum* with small corallites, 2 or 3 mm. in diameter.

Description.—No complete corallum has been found; the largest fragment is 7 x 3 x 3 cm. The corallum is cerioid and the individual corallites are usually 3 mm. in diameter, though a few are 4 mm., and some may be 2 mm. The walls between corallites are rather thick (0·5 mm.), the septal bases of neighbouring corallites are alternate or sub-opposite. The 12 or 13 major septa extend from the wall, without curvature, almost to the axis, where they may be slightly interdigitated; in some corallites two opposite septa appear to be joined at the axis. The minor septa are two-thirds to three-quarters as long as the major septa in the type; no vertical discontinuity was observed in either order, but both are slightly waved. The tabularium is about one-third as wide as the corallite and the tabulae are complete and sagging, rather distant. There are three or four series of globose dissepiments, the inner series being more steeply inclined than the outer.

Remarks.—All specimens are badly preserved. At Silverwood, in addition to the type locality, the species occurs at Lomas North, while much re-crystallised material doubtfully placed in it has been collected from Barnes' Qy. and Oakey Creek. It also occurs in the Tamworth District, New South Wales, on the Manilla road, 15 miles from Tamworth (i.e., near Attunga), where it is associated with *Litophyllum konincki* Etheridge and Foord. This outcrop was considered by Etheridge (1899, p. 182) as almost certainly on the same horizon as the Moore Creek and Woolomol Limestones. These are probably Givetian.

Family STREPTELASMIDAE.

Typical Genus: *Streptelasma* Hall.

Simple Rugosa without dissepiments; the septa are at first dilated throughout, but later extreme dilatation is confined to a narrow peripheral stereozone; the axial edges of the major septa are denticulate, and may interweave to form an axial structure; the tabulae are domed, and complete or incomplete.

Range.—Ordovician and Silurian of Europe and America; Lower Devonian of France; Middle Devonian of North America and Australia.

Remarks.—I include in this family the European Ordovician *Dybowskia* Wedekind (1927, p. 18) which has short major septa and complete, distant tabulae, and which, according to Scheffen (1933, p. 16) occurs also in the Silurian and Devonian of North America; the European and American *Streptelasma* of the Ordovician, Silurian, and Devonian; and the two possibly synonymous Ordovician Baltic genera *Grewingkia* and *Kiaerophyllum* listed below, in which the denticulate axial ends of the septa unite to form a wide axial structure. The value of these generic names is doubtful; all the morphologies seem to belong to a connected series, and all have a long and wide distribution. *Dinophyllum* Lindström from the European Middle Silurian is possibly a member of this family. It has, however, a much larger fossula than typical members, and the axial ends of the septa do not appear to be

denticulate. Possibly three American Devonian genera founded by Simpson (1900) might be Streptelasmids—*Enterolasma* (Helderberg = Lower Devonian); *Kionelasma* (Niagaran to Upper Helderberg = Wenlock to top of Lower Devonian); and *Scenophyllum* (Onondaga = Couvinian).

Genus *Streptelasma* Hall.

Streptoplasma [sic] Hall, 1847, pp. 17, 49, 69-71.

Streptelasma Hall, 1847, explanation to pl. iv., &c.

? *Grewingkia* Dybowski, 1873, p. 384 (genolectotype, chosen Wedekind, 1927, p. 18, *Grewingkia formosa* Dybowski, 1873, p. 132), Ordovician, Baltic States.

? *Dybowskia* Wedekind, 1927, p. 18 (genotype by designation *D. prima* Wedekind *id.*), Ordovician, Gotland.

? *Kiaerophyllum* Wedekind, 1927, p. 17 (genotype by designation *K. kiaeri* Wedekind *id.*), Ordovician, Gotland.

Streptelasma; Smith, 1930, p. 311.

Streptelasma; Cox, 1937, p. 2.

Genolectotype.—*Streptoplasma* (sic) *corniculum* Hall, 1847, p. 69, pl. 25. figs. 1a-d. Trenton Formation of Trenton Falls, &c., New York State. See Cox *loc. cit.*

Diagnosis.—As for family.

Remarks.—As noted under remarks on the family, I cannot see the wisdom of separating the genera listed above, since the morphological differences are only of degrees, and all are widespread and long ranged.

Streptelasma sp. (Plate III., fig. 6.)

Material.—One specimen, F 3426, University of Queensland Collection. Silverwood. Probably from Limestone Siding.

Description.—In an obliquely transverse section 9 mm. in diameter, 34 major septa extend about two-thirds of the way to the axis, and alternate with an equal number of minor septa a little over 1 mm. long; at their peripheral ends both orders are dilated and in contact to form a narrow stereozone about 1 mm. wide; in the tabularium the dilatation of the septa is less; the axial edges of the major septa are denticulate, and the irregular denticulations form a loose spongy border to an axial space about 1 mm. in diameter, which is almost free of septal ends. From their cut plates, the tabulae appear to be domed and rather distant. There are no dissepiments.

Remarks.—The denticulate axial edges of the septa and the narrow peripheral stereozone clearly indicate that this specimen is a *Streptelasma*; it is too incomplete to be given a specific name; possibly an examination of specimens of the American Devonian genera *Enterolasma*, *Kionelasma*, and *Scenophyllum* would give some correlations.

ACKNOWLEDGMENTS.

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EXPLANATION OF PLATES.

PLATE II.

All specimens are from the Middle Devonian (Couvinian) of the Silverwood District, S.E. Queensland, and are now in the Collection of the Department of Geology of the University of Queensland.

All figures (except fig. 7) approximately by $1\frac{2}{3}$ diameters.

Fig. 1. *Acanthophyllum* sp., cf. *mansfieldense* (Dun), F3412, Barnes' Qy. 1a. Transverse section. 1b. Vertical section.

Fig. 2. *Acanthophyllum* sp. F3413. Limestone Siding. Transverse section.

Fig. 3. *Acanthophyllum* sp. F3415. Silverwood. 3a. Transverse section. 3b. Vertical section. 3c. Tangenitial section of septa.

Fig. 4. *Prismatophyllum latum* sp. nov. F3417. Barnes' Qy. Holotype.

Fig. 5. *Prismatophyllum densum* sp. nov. F3416. "Large *Tryplasma* horizon." 5a. Transverse section. 5b. Vertical section. Holotype.

Fig. 6. *Fasciphyllum* aff. *conglomeratum* (Schlüter). F3418. Limestone Siding. 6a. Vertical section. 6b, c. Transverse section.

Fig. 7. *Fasciphyllum conglomeratum.* (Schlüter). Givetian, Eifel. Diagrammatic sections, after Lang and Smith. x 4 diameters.

PLATE III.

All specimens are from the Middle Devonian (Couvinian) of the Silverwood District, S.E. Queensland, and are now in the Collection of the Department of Geology of the University of Queensland.

All figures approximately by $1\frac{2}{3}$ diameters.

Fig. 1. *Pseudamplexus* sp. F3420, Lomas North. 1a. Transverse section of septa. 1b. Median vertical section of a septum. 1c. Tangential section of septa.

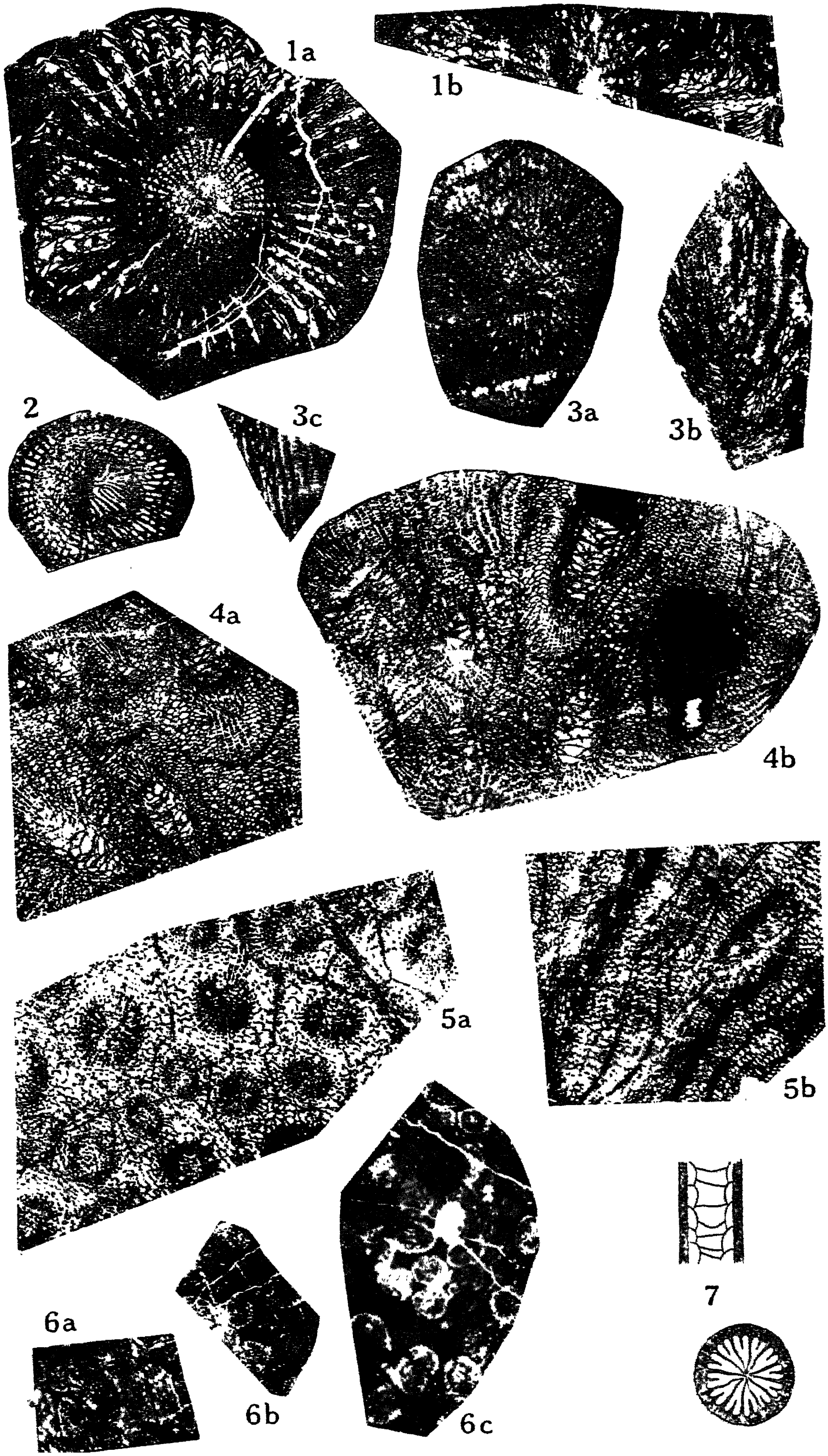
Fig. 2. ? *Chlamydophyllum* sp. F3422. ? Limestone Siding. 2a. Transverse section. 2b. Part of vertical section. 2c. Tangential vertical section of septa. 2d. Transverse section of septa.

Fig. 3. *Spongophyllum halysitoides* var. *minor* var. nov. F3423. Holotype. Limestone Siding.

Fig. 4. *Xystriphyllum dunstani* (Etheridge). Geol. Surv. Colln. Mullin's Paddock, Lucky Valley.

Fig. 5. *Xystriphyllum insigne* sp. nov. F3425. Holotype. Limestone Siding.

Fig. 6. *Streptelasma* sp. F3426. ? Limestone Siding.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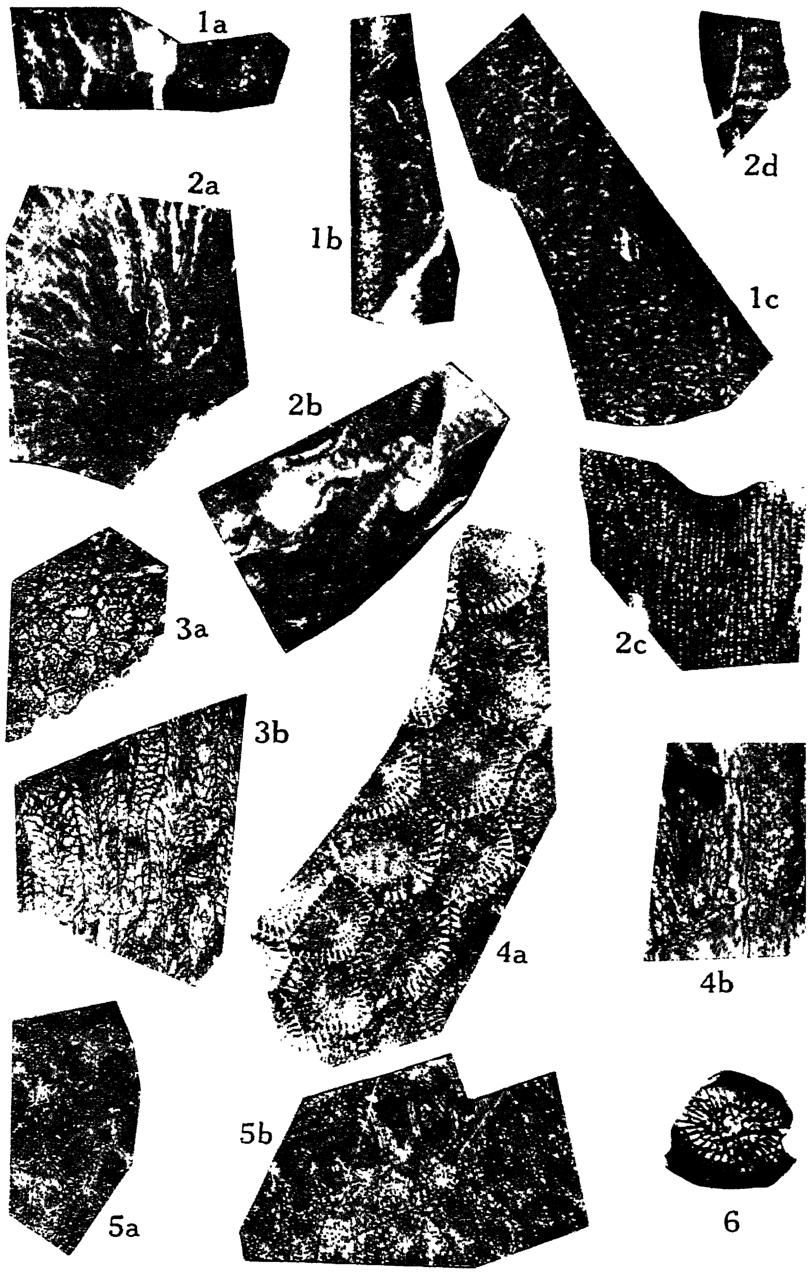

Middle Devonian Rugose Corals.

STUDIES ON QUEENSLAND GRASSES, I.

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(*Read before the Royal Society of Queensland, 27th November, 1939.*)

PLATES IV. AND V.

This is the first of a series of papers in which are to be presented previously undescribed species, new records for Queensland, and notes of a taxonomic, ecological, or economic nature on various genera and species of the Gramineae, serving either as introductory notes to more complete accounts of the groups concerned or as addenda to previously published works. In this paper some preliminary notes on that most difficult genus *Aristida* are presented. Between the years 1926 and 1933 two monumental works on the genus by J. T. Henrard were published in Mededeelingen van 's Rijks Herbarium, viz., "A Critical Revision of the Genus Aristida" and "A Monograph of the Genus Aristida." In these 33 species and 6 varieties are described as occurring in Australia, nearly all of which are now known to occur in Queensland. Field work, supplemented by intensive collecting, carried out in very many localities in Queensland, has testified to the accuracy of Henrard's species-concept within the genus, although it has been found that to give an accurate idea of many species the circumscriptions of these will have to be widened. This is particularly so in the case of the lengths of the spikelet-parts, while the character of normal and inverse glumes is not so reliable as one might wish. Hybridism may very likely, as suggested by Henrard, play a very big part in producing some of the extraordinarily difficult forms encountered in such complex series of forms as those centring around *A. calycina* and *A. glumaris*, and *A. pruinosa* and *A. inaequiglumis*. In this paper only some of the more outstanding forms are dealt with.

Except where stated to the contrary, all collections cited have been personally examined, and are represented in the Queensland Herbarium, Brisbane, where also the actual types of the new species here described are deposited.

Aristida acuta *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. glumari* Henr. et *A. praealtae* Domin, ab hac foliorum vaginis collo glabris, panicula pauciore haud rigida, ab illa panicula laxiore ejus ramis longioribus filiformibusque, ab utraque paniculae ramulis spiculisque appressis, glumis ambabus acutissimis, differt.

Gramen perenne, caespitosum, viride. *Culmi* numerosi ± patentes, 3-nodes, e nodis inferioribus ramosi, graciles, teretes vel subcompressi, tenuiter striati, ceterum glabri laevesque, panicula inclusa 40-65 cm. longi. *Folia* haud numerosa; vaginae internodiis breviores vel multo breviores, prominule striatae, glabrae, minute scaberulae vel fere laeves; ligula brevissima, dense ciliata; auriculae vix incrassatae, pubescentes, nec barbatae vel innovationum parce barbatae; collum glabrum; laminae angustae, apice setaceo-attenuatae, usque ad 14 cm. longae, subrigidae, involutae vel convolutae, applanatae usque ad 2 mm. latae, nervis pluribus validis crebre percursae quorum 3 aliis crassiores, pagina superiore hirtellae, inferiore minute scaberulae. *Panicula* exserta

plerumque 15-30 cm. longa, laxa, ± nutans saepe quasi-secunda; rhachis gracilis, ± trigona, sursum ± compressa, marginibus scaberula vel omnino fere laevis; rami singuli, remoti, filiformes, internodiis paullo longiores, primo suberecti tandem (saltem inferiores) patuli vel subnutantes (in siccitate ± flexuosi), a basi pubescenti divisi, imus usque ad 8·5 cm. longus; ramuli pedicellique pauciores appressi, hi spiculis breviores, scabridi, apice subclavati. *Spiculae* haud densae, ± violaceo-coloratae. *Glumae* certe inversae, lineari-lanceolatae, membranaceae, hyalinae vel dilute coloratae, 1-nerves, glabrae, fere omnino laeves, sursum gradatim acuminata acutissima; inferior carina parce scaberula, aristulata, aristula 1-1·2 mm. longa inclusa 8·5-10·7 mm. longa; superior 1-1·7 mm. brevior, vix aristulata, 7·5-9 mm. longa. *Lemma* lineare, utrinque angustatum, dense punctulato-scaberulum, marginibus involutum hinc ventre sulcatum, callo fere recto dense barbato ca. 1 mm. longo incluso 8·5–9 mm. longum. *Columna* nulla. *Aristae* subsimiles, scabrae, oblique patentes, basi haud applanatae, 13-19 mm. longae, medialis lateralibus 4-5 mm. longior paullo robustior. —Plate IV., figs. 1-3.

QUEENSLAND.—Moreton District: Near Villeneuve, on upper hill-slopes in cleared Eucalyptus forest on grey podzolised soil, 400 feet, Feb. 22nd, 1939, *Blake* 13960 (TYPE); Petrie, on somewhat open ground on poor soil, Dec. 28th, 1930, *Blake* 94.

This species is readily distinguished by its lax habit, prominently inverse very acute glumes, and furrowed lemma. The primary branches of the panicle are bipartite or tripartite shortly above the base, the longer or longest secondary branch is naked for at least half its length, while the other or others are much shorter and bear 1-3 spikelets.

Aristida dissimilis *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. glumari* Henr. a qua panicula minus rigida ejus ramis ramulisque appressis, gluma inferiore dense scaberula, aristis lateralibus breviusculis capillaribus differt.

Gramen perenne, caespitosum, suberectum, viride. *Culmi* numerosi, stricti vel leviter geniculati, teretes, leviter striati, fere laeves sed sub panicula scabri, 2–3–nodes, plerumque simplices raro parce ramosi, cum panicula 40–60 cm. longi. *Folia* pauca; vaginae internodiis multo breviores, arctae, persistentes vel inferiores delapsae, prominule nervosae, subcarinatae, glabrae, minute scaberulae; ligula brevissima dense ciliolata; auriculae breviter pubescentes; collum glabrum; laminae anguste lineares apicem versus acutatae, firmae nec rigidae, vel planae vel involutae vel sursum convolutae, (applanatae) 1–1·5 mm. latae, pagina superiore scaberulae, inferiore laeves, usque ad 20 cm. longae sed plerumque multo breviores. *Panicula* tandem longe exserta, plerumque 10–20 cm. longa, laxiuscula, interrupta, pauciramosa; rhachis angulata scabra; rami bini, vel singuli et fere ad basin furcati, suberecti, internodiis breviores, gracillimi, scabri, parte superiore pauciramulosi; pedicelli spiculis breviores apicem versus subclavati. *Spiculae* erecti, purpurascentes vel violascentes. *Glumae* inversae, lineari-lanceolatae, aristulatae, firme membranaceae, 1–nerves; inferior gradatim acuminata, carina scabra ceterum dense scaberula, cum aristula 9–10 mm. longa; superior plerumque 0·5–1 mm. brevior, apice abrupte acuminata ± biauriculata, fere laevis, aristula inclusa 8–9 mm. longa. *Lemma* anguste lanceolatum, aliquantulum complanatum, ventre sulcatum ob margines involutas, dense punctulatum, cum callo obliquo

obtuso 0·7–0·9 mm. longo dense longeque barbato 8–8·5 mm. longum. *Columna* nulla. *Aristae* valde inaequales, hispidae, erectae vel suberectae, medialis inferne robusta, 10–14 mm. longa, laterales multo breviores gracilioresque 5–8 mm. longae.—Plate IV., figs 4-7.

QUEENSLAND.—North Kennedy District: Townsville, on sandy soil on the exposed rocky slopes of Castle Hill, and in Eucalyptus forest, June 7th, 1934, *Blake* 5945 (TYPE); and on roadsides, *Blake* 5957.

Distinguished by the rather plump spikelets with scaberulous lower glumes, and the dissimilarity between the ± erect awns, of which the central is rather robust while the lateral ones are very slender and only $\frac{1}{2}$–$\frac{2}{3}$ as long.

Aristida helicophylla *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. jerichoensi* Domin et *A. ingratae* Domin, ab illa tamen foliis omnibus persistentibus planis circinatis, ab hac gracilitate, foliis angustioribus, collo glabris, spiculis minoribus, ab utraque aristis leviter recurvatis flexuosisve differt.

Gramen perenne, caespitosum, glauco-pruinosum, usque ad 1 m. altum. *Culmi* stricti vel fere stricti, erecti, simplices vel pauciramosi, 2–3–nodes, graciles, leviter compressi, leviter striati, valde pruinosi, ceterum glabri laevesque, nodis leviter incrassati. *Folia* pruinosa; vaginae arctae vel inferiores ± hiantes, internodiis subduplo breviores, sulcatae, scaberulae, collo incluso glabrae; ligula longe denseque ciliata; auriculae pubescentes; laminae anguste lineares, planae vel praesertim superne ± complicatae, flexuosae, usque ad 20 cm. longae, 1·5–2 mm. latae, valide multinerves nec carinatae, pagina superiore longiuscule denseque hirtellae, inferiore scaberulae, veterae semper planae laxe tortae ± circinatae. *Panicula* exserta vel longe exserta, stricta, angusta, continua, densiuscula, 12–25 cm. longa; rhachis hicinde visibilis, angulata, sursum scabrida; rami graciles, plerumque bini, a basi divisi, rhacheos internodiis plerumque longiores, inferiores usque ad 5 cm. longi, cum ramulis pedicellisque stricti, appressi, erecti. *Spiculae* longiuscule pedicellatae, pedicellis subclavatis spiculis brevioribus. *Glumae* subaequales, plerumque inversae, membranaceae, 1–nerves; inferior acute acuminata, aristulata, carina scaberula, ceterum brevissime scabrociliolata, 6·2–7·7 mm. longa; superior angustior, usque ad 0·7 mm. brevior, apice profunde biloba, inter lobos angustissimos aristulata, 6–7 mm. longa. *Lemma* glumis multo brevius, atrofuscum vel atromaculatum, lineari-ellipticum, admodum compressum, punctulatum, ventre sulcatum, marginibus involutis pilis brevibus antrorsim conicis albidis interdum praeditum, cum callo acutissimo 0·8 mm. longo dense barbato 4·2–4·5 mm. longum, 0·55 mm. latum. *Columna* nulla. *Aristae* lemmate quasiarticulatae (i.e. inter lemma aristasque sulcus angustus adest), pallidae, subsimiles, capillares, leviter recurvae vel flexuosae, 17–21 mm. longae. —Plate IV., figs. 8-12.

QUEENSLAND.—Mitchell District: Between Jericho and Lochnagar on sand in mixed open forest, ca. 1,100 feet, July 17th, 1934, *Blake* 6875; east of Jericho in mixed open forest on sand, ca. 1,250 feet, July 16th, 1934, *Blake* 6822; near Jericho on rocky crest of low range on shallow reddish sand among low shrubs and *Triodia*, ca. 1,500 feet, July 15th, 1934, *Blake* 6807. Warrego District: Between Charleville and Westgate on red sand associated with *Eucalyptus melanophloia* and *Triodia*, April 20th, 1934, *Blake* 5411 (TYPE).

The persistent flat old leaves curled somewhat in the manner of a watch-spring, and the very slender flexuose or curved awns give this species quite a distinctive appearance. The leaves are very similar to those of *A. ingrata* Domin, but they are narrower, and lack the characteristic villous line across the collar. There is a distinct narrow but rather deep constriction between the lemma and the awns, and also a marked differentiation in colour between them, but there is no differentiation in tissue and therefore no articulation. The lower glume is usually the longer, but rarely it is shorter than the upper.

Aristida exserta *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. queenslandicae* Henr. a qua praecipue internodiis glabris, lemmate angustiore longius exserto, aristis minus inaequalibus differt.

Gramen perenne, caespitosum, pallide viride, 30–60 cm. altum. *Culmi* erecti, stricti, graciles, ½–1 mm. crassi, teretes, tenuiter striati, ceterum laeves vel fere laeves, glabri, 2–3–nodes, e nodis omnibus ramosi. *Folia* pauca; vaginae arctae vel inferiores tandem hiantes, striati, ceterum fere laeves, internodiis multo breviores; ligula brevissima longe denseque ciliata; auriculae pubescentes; collum glabrum; laminae subsetaceae, rigidae, leviter curvatae vel flexuosae, involutae et quasi-teretes (applanatae usque ad 1 mm. latae), nervis validis paucis percursae, marginibus scabrae, pagina superiore breviter hirtellae, inferiore glabrae laevesque. *Panicula* longiuscule exserta, stricta, erecta, angusta, ± interrupta, 10–15 cm. longa, 1 cm. lata raro metiens (aristis exclusis); rhachis compresse trigona, marginibus scaberula, bene visibilis; rami singuli, erecti, filiformes, a basi divisi, rhacheos internodiis breviores; ramuli pauci; pedicelli spiculis breviores, anguste clavati, scabridi. *Spiculae* pallidae vel violascentes. *Glumae* inversae, lineari-lanceolatae, glabrae laevesque; inferior acuminata longiuscule aristulata, 3–nervis, manifeste carinata, aristula 0·5–0·75 mm. longa inclusa 7–8·7 mm. longa; superior prominule brevior, 1–nervis, breviter biloba, aristulata (aristula ca. 0·5 mm. longa inclusa), 6·5–7 mm. longa. *Lemma* glumis manifeste longius, angustissime lanceolatum fere subulatum, prope basin leviter angustatum, sursum longe angustatum, ventre sulcatum (marginibus involutis), prope apicem ciliatulo-scabrum ceterum glabrum laeveque, callo brevi admodum obliquo 0·4–0·5 mm. longo dense barbato incluso 8–10 (plerumque 9) mm. longum. *Columna* nulla. *Aristae* subsimiles subaequales, 8–12 mm. longae.—Plate V., figs. 6-9.

QUEENSLAND.—North Kennedy District: Near Pentland on Mount Remarkable and neighbouring peaks in open forest, June 11th, 1934, *Blake* 6130 (TYPE).

A slender species fairly readily recognised by the setaceous leaves, very narrow scanty inflorescence, inverse glumes, and narrow attenuate furrowed lemma at least 1 mm. longer than the glumes and usually more. The shape of the lemma approaches that of *A. ramosa* R. Br., but it is furrowed, and the species abundantly differ in many other characters.

Aristida intricata *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. Warburgii* Mez sed foliis hispidis, culmis distincte compressis scabris, spiculis in omni parte brevioribus, gluma prima hirtella, lemmate sursum scabro-hispido differt.

Gramen perenne caespitosum viride. *Culmi* graciles, basi ± erecti, sed sursum tandem patentes, compressi, antrorsim scabri, panicula.

inclusa usque ad 90 cm. longi, simplices, 1–2–nodes, internodio supremo (pedunculo) longe exserto usque ad 50 cm. longo sublaevi. *Folia* plura; vaginae internodiis breviores, arcte appressae, striati, scabrae; ligula brevis dense breviterque ciliolatae; auriculae inconspicuae pilis longis paucis barbatae vel glabrae; laminae angustissime lineares, longe attenuatae, valde complicatae, applanatae usque ad 1·8 mm. latae, pagina superiore hirtellae, inferiore scabro-hirtellae. *Panicula* angusta, ± nutans, contracta sed haud densa, saepe quasi-secunda; rhachis angulata scabra, bene visibilis; rami singuli vel sub-bini, internodiis rhacheos breviores (inferiores usque ad 80 mm. longi, basi vel prope basin 1–ramulosi, saepe autem apicem versus ramulos 1–2 gerentes), tenuissime filiformes, sub flore saepe patentes, ± nutantes, sub fructu ± erecti et appressi, scaberuli, plerumque 3–1–spiculosi; pedicelli angulati, subclavati, scabri, laterales 1·5–4 mm. longi, terminales usque ad 12 mm. longi. *Spiculae* purpureo-suffusae, maturitate ob aristas tortas inter se innexae. *Glumae* normales, marginibus involutae; inferior lineari-lanceolata, acuta, valde 3–nervis, nervis percurrentibus, carina scabra, ceterum hirtella, vel margines versus glabra, plerumque 6–7, raro 5, mm. longa; superior $\frac{1}{3}$–$\frac{1}{4}$ longior, angustior, apice abrupte acuminata, 1–nervis, carina sursum scabridula excepta glabra laevisque, admodum patula sed a latere visa incurva, 8·5–11 mm. longa. *Lemma* angustissime lanceolatum, prominule carinatum, haud sulcatum, marginibus convolutum, parte superiore vel tota margine exteriore parce scabrum, ceterum glabrum laeveque, cum callo 7–8 mm. longum; callus leviter curvatus, pungens, 1·2–1·5 mm. longus, pilis albis usque ad 1 mm. longis dense barbatus. *Columna* lemmate vix tenuior, scabra, valde torta, 11–13 mm. (cum lemmate calloque 19–21 mm.) longa, sursum saepe ± flexuosa. *Aristae* scabrae, media robusta 17–19 mm. longa , basi recurvata, laterales multo tenuiores, ± filiformes, 12–14 mm. longae, divaricatae, vel omnes laxe spiraliter contortae vel media solum contorta.—Plate V., figs. 1-5.

QUEENSLAND.—Wide Bay District: Near Bundaberg, on hill slopes in Eucalyptus forest, April 27th, 1936, *Blake* 11325A; Howard, *Watson* 13. Moreton District: Bribie Island, in flat sandy country, April 30th, 1916, *White*; Caloundra, in open forest on sandy soil, August 24th, 1932, *Blake* 305; Caboolture, May 2nd, 1931, *Mayze in Herb. Blake* 180; Lawnton, near Brisbane, at edge of dried-up swamp, March 28th, 1932, *Blake* 252; Blackheath, April 23rd, 1918, *White*; Virginia, Brisbane, fairly common in *Melaleuca nodosa* forest on ill-drained light grey sandy loam, 25 feet, June 3rd, 1939, *Blake* 14097 (TYPE); Sunnybank, near Brisbane, June 2nd, 1914, and March, 1918, *White*.

Very similar in appearance to *A. Warburgii* Mez, and like it forms rather leafy tufts with long flexuose peduncles straggling over the ground. *A. perniciosa* Domin of North Queensland has a similar habit, although Domin describes the species as strictly erect. *A. intricata* is rather common in the coastal districts of South-east Queensland in flattish often ill-drained deep sandy soil in wallum communities and related forest communities, usually in damper places than *A. Warburgii*. At maturity, the awns are usually more or less strongly spirally twisted and intertwined, so that the lemmas are shed in groups. This, in addition to the difficulty at first experienced in distinguishing immature specimens from immature specimens of *A. Warburgii* (almost all the earlier collections of these species are more or less immature) suggested the specific epithet.

For note on *A. Warburgii* Mez and *A. heterochaeta* Henr. see below.

Aristida platychaeta *S. T. Blake* sp. nov. (sect. *Chaetaria*) affinis *A. muricatae* Henr. et *A. anthoxanthoidi* Henr., ab hac inflorescentia laxiore, lemmatis marginibus convolutis nec involutis, callo longiore, aristis basin versus dilatatis planisque, ab illa partibus omnibus minoribus, lemmate a medio utrinque angustato, callo paullo angustiore, aristis basi applanatis distinguenda.

Gramen perenne, caespitosum, viride vel ± atro-violaceum usque ad 50 cm. altum. *Culmi* erecti vel basi geniculati graciles, teretes, striati, glabri laevesque, 1–2–nodes, internodium summum (pedunculus) longissimum, cetera brevia. *Foliorum* vaginae arctae, internodiis breviores vel inferiores iis subaequales longioresve, prominule striatae, minutissime scaberulae; ligula dense ciliata; auriculae pubescentes, pilis longis paucis sparse barbatae; collum glabrum; laminae ± flexuosae usque ad 15 cm. longae, convolutae vel basin versus planae, vel fere totae planae, 1–2 mm. latae, pagina superiore dense hirtellae inferiore glabrae laevesque vel scaberulae, nervis pluribus utrinque percursae quorum 3 ceteris crassiores, marginibus incrassatae sursum scaberulae. *Panicula* longe exserta, 10–20 cm. longa, aristis inclusis ca. 2–3 cm. lata, spiciformis haud densa, inferne saepe ± interrupta; rhachis visibilis, angulata, striata, parce scaberula vel fere laevis; rami internodiis multo breviores, bini, a basi divisi, cum ramulis pedicellisque erecti, filiformes, scaberuli, pedicelli spiculis breviores vel terminales longiores. *Spiculae* ± violaceo-coloratae. *Glumae* membranaceae, subaequales, 5–7 mm. longae, lineari-lanceolatae, 1–nerves; inferior acuta, cuspidata, aristula usque ad 0·5 mm. longa, carina interdum quoque lateribus sursum scabrida; superior paullo longior vel raro brevior, paullo angustior, abrupte acuminata, apice ± minute ciliolata, carina laevis. *Lemma* tubulosum, angustum, fusiforme, marginibus convolutum, inferne punctulatum, sursum scabrum atque pilis hyalinis albis conicis antrorsis dense praeditum, cum callo obtuso oblongo longiuscule denseque barbato 1 mm. longo 5–6 mm. longum. *Columna* nulla. *Aristae* inter se similes, subaequales, 12–18 mm. longae, oblique patentes, basi plana latiuscula marginibus scabridae, ± tortae, sursum setaceae, scabrae.—Plate V., figs. 10-13.

QUEENSLAND.—Warrego District: Chesterton, approx. 25° 20′ S., 147° 20′ E., on grassland slope on dark grey silt clay, ca. 1,800 feet, April 7th, 1936, *Blake* 11072; Morven, in grassland on dull brown silt clay, ca. 1,400 feet, April 2nd, 1936, *Blake* 11002. Maranoa District: Mitchell, on open downs on dark greenish brown silty clay, 1,100 feet, May 3rd, 1934, *Blake* 5701 (TYPE); Roma, in cemetery reserve on sand, ca. 1,000 feet, May 6th, 1934, *Blake* 5786; Noondoo, near Dirranbandi, on grey silt clay plain with scattered *Eucalyptus coolabah*, 550 feet, Feb. 27th, 1936, *Blake* 10574.

One of the very few species of the genus regularly found on heavy soils. Although an element in the grassland climax, it tends to dominate overgrazed areas in some places. The rather broad flat thin bases of the awns are very characteristic, though they also occur to a more or less extent in other forms. The glumes are almost always normal, but very occasional instances of the inverse position were observed.

A. anthoxanthoides (*Domin*) *Henr.* l.c. No. 54, 29 (1926); *A. peregrina* Henr. l.c. 16 (1926). *A. adscensionis* L. var. *anthoxanthoides* Domin in Biblioth. Bot. xx. Heft 85, 343 (1915), and var. *subaequiglumis* Domin, l.c.

Henrard based his *A. peregrina* on the description of *A. adscensionis* var. *subaequiglumis* Domin without having seen the type, but later, after having seen the specimens, he united it with *A. anthoxanthoides* (l.c. 438). Henrard has however erred in describing the lemma as tubular with overlapping margins (see particularly the Monograph, p. 303, and the key on p. 294). I have seen specimens from the type-collections of both Domin's varieties, and in these as in all other specimens I have seen, the lemma is prominently ventrally furrowed with inrolled margins. It is thus impossible to determine specimens from the key.

A. anthoxanthoides is fairly common in Western Queensland, chiefly in the far west, occurring often as a pioneer on bare ground such as clay-pans.

A. obscura *Henr.* l.c. No. 54A, 385 (1927). Henrard's description of this species seems to have been based on poor material, to judge from the material of the type collection in Herb. Sydney received on loan through the courtesy of Mr. R. H. Anderson. Particularly during 1936 I collected an excellent series of specimens, but owing to the inadequate description had been at a loss to place them. Two notable characteristics appear to have been overlooked by Henrard. Firstly the uppermost internode (peduncle) is very thin and strongly flattened sometimes concavo-convex, a feature prominent both in the field and in the herbarium. Secondly, the lemma is strongly and densely antrorsely hispid all over. The awns are much longer than described by Henrard, up to 45 mm., but are apparently broken in the type, while the glumes are distinctly aristulate. The panicle in well-developed specimens has the branches bipartite or tripartite at the base and longer. There is no essential difference between the general structure and appearance of the panicle of this species and of *A. Leichhardtiana* Domin and the two species are closely allied, although Henrard places them in different inflorescence-groups (cf. Monograph, 208). The internodes of the latter species are at times slightly hirtellous, but the uppermost internode is always terete, and the lemma is smooth. The spikelets are also slightly smaller, and the leaves are not flat.

A. obscura var. *luxurians* Henr. l.c. 54c, 729 (1933), seems likely to be the hybrid *A. Behriana* × *A. obscura*. The peduncle is terete, and the other characters seem to be as much those of *A. Behriana* as of *A. obscura*. I have not seen the type collection of this form, but there are two collections in Herb. Sydney from the type locality (Nyngan) which match the description. Is it merely a coincidence that this "variety" is known only from the only locality from which both *A. Behriana* and *A. obscura* have been collected?

A. Warburgii *Mez* in Fedde, Rep. Spec. Nov. xvii. 149 (1921); Henr. in Meded. Herb. Leid. No. 54B, 681 (1928). *A. heterochaeta* Henr. l.c. No. 54A, 227 (1927).

Through the courtesy of Dr. Pilger I have received an excellent photograph and fragments of the type of *A. Warburgii* in the Berlin Herbarium, while through the courtesy of Mr. R. H. Anderson I have had the loan of specimens of the type collection of *A. heterochaeta*. In both cases the specimens are somewhat immature, but they are certainly conspecific. It was unfortunate that Henrard was unable to see *A. Warburgii*, but it is strange that while discussing its possible identity he omitted his *A. heterochaeta* from the list of the species with 3-nerved

lower glumes and a twisted column. It is probable that he did not consider this species to be involved as Mez did not mention the diversity of the awns in his description.

A. Warburgii varies rather considerably in the degree of heterogeneity of the awns and in the degree of their curvature. Sometimes the central awn is nearly horizontal with the laterals suberect; at other times all are more or less curved, the median strongly recurved and in addition twisted away from the lemma. In the preparation of herbarium specimens this torsion is usually sufficient to wrench mature lemmas from the glumes, so that really good mature specimens are almost unknown in herbaria. Some very young specimens in Herb. Sydney were compared by Henrard with *A. hirta* Domin (according to herbarium notes by Miss Vickery) and one very young specimen in Herb. Brisbane has been identified by Henrard with this species. *A. hirta* Domin and *A. superpendens* Domin are species with heterogeneous awns belonging to the sect. *Arthratherum*, but there is no trace of an articulation at the base of the column in *A. Warburgii* or *A. intricata*. I am not exactly sure which is *A. hirta* Domin. I have collected and seen several series of specimens from Domin's type locality and neighbouring places belonging to two distinct allied species, but I have not seen a single specimen which matches exactly both the descriptions and figures of either Domin or Henrard. Certain rather stout forms of *A. Warburgii* from near Brisbane however, are very similar in outward appearance to what I take to be typical *A. superpendens*.

In another form the column is unusually short (7–8 mm.) with the callus also slightly shorter than usual.

EXPLANATION OF PLATES.

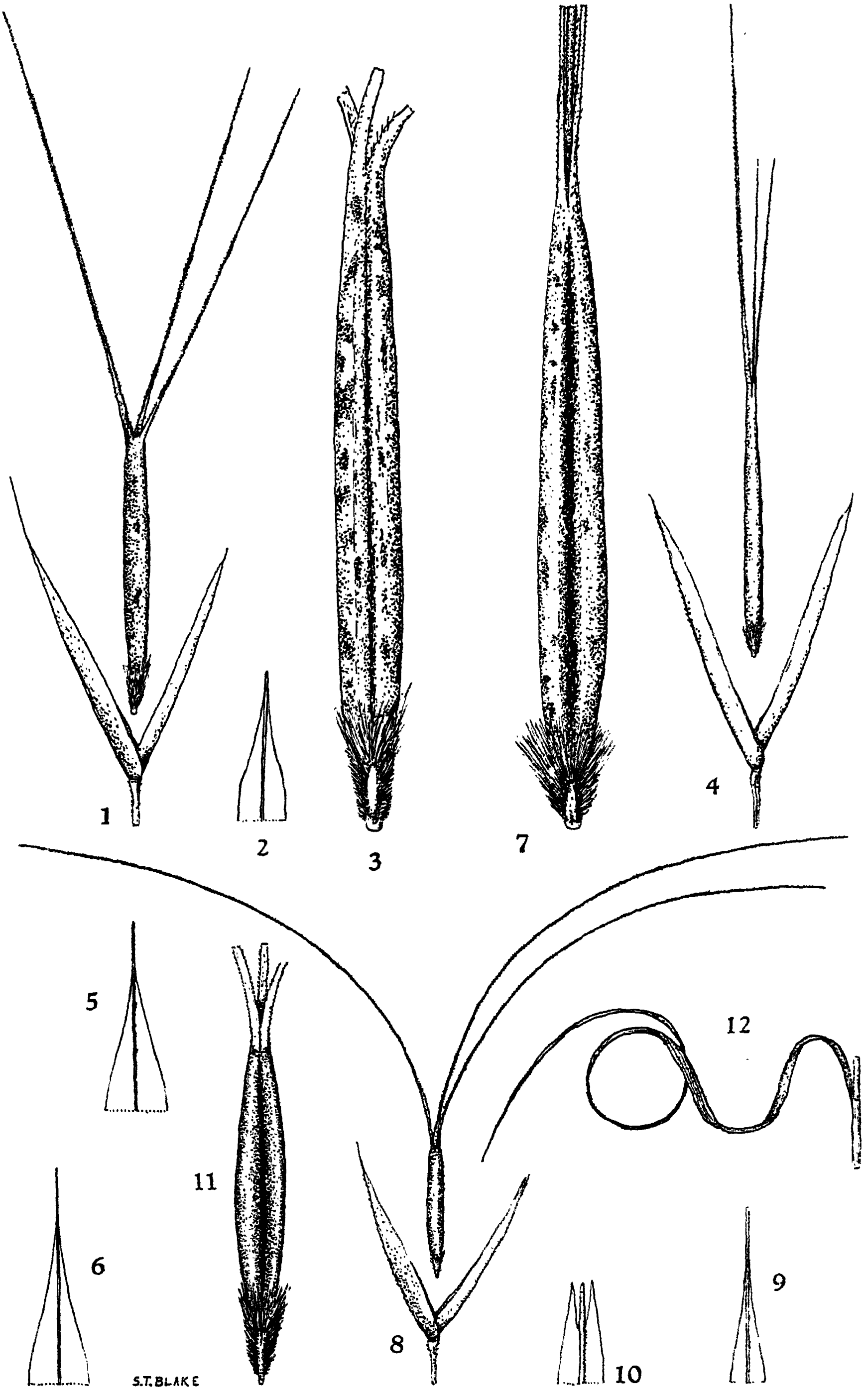
In all cases spikelet (with lemma separated) × 4, lemma (with upper part of awns removed) and apices of glumes × 10. All figures drawn from type specimens.

Plate IV.

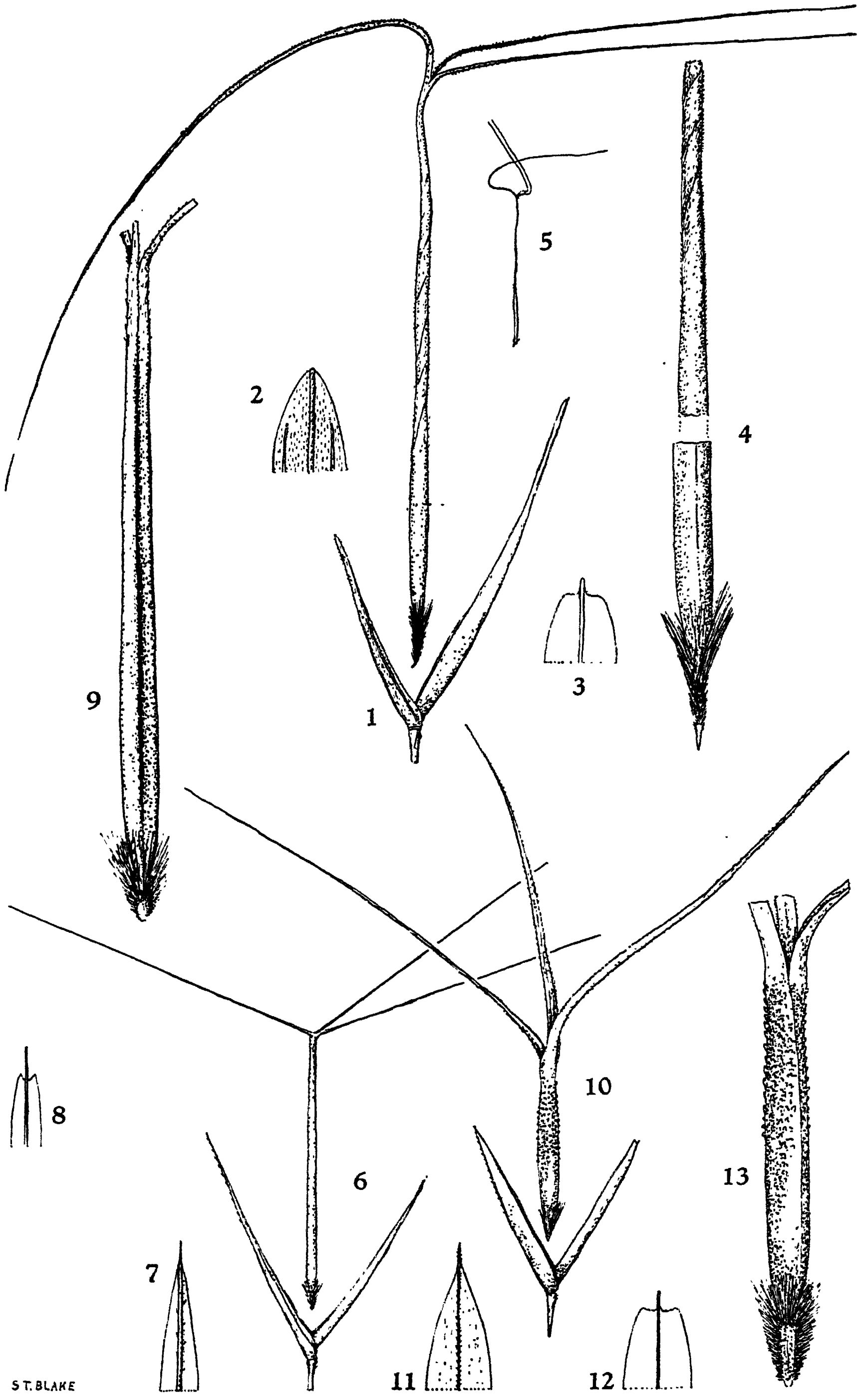
Figs. 1-3, *Aristida acuta* S. T. Blake: 1, spikelet; 2, apex of upper glume; 3, lemma. Figs. 4-7, *Aristida dissimilis* S. T. Blake: 4, spikelet; 5, apex of lower glume; 6, apex of upper glume; 7, lemma. Figs. 8-12, *Aristida helicophylla* S. T. Blake: 8, spikelet; 9, apex of lower glume; 10, apex of upper glume; 11, lemma; 12, old leaf, *natural size*.

Plate V.

Figs. 1–5, *Aristida intricata* S. T. Blake: 1, spikelet; 2, apex of lower glume; 3, apex of upper glume; 4, portions of lemma; 5, another lemma, *natural size*, to show variation in twist of awns. Figs. 6-9, *Aristida exserta* S. T. Blake: 6, spikelet; 7, apex of lower glume; 8, apex of upper glume; 9, lemma. Figs. 10–13, *Aristida platychaeta* S. T. Blake: 10, spikelet; 11, apex of lower glume; 12, apex of upper glume; 13, lemma.



Figs. 1-3, *Aristida acuta* S. T. Blake. Figs. 4-7, *Aristida dissimilis* S. T. Blake. Figs. 8-12, *Aristida helicophylla* S. T. Blake.



Figs. 1-5, *Aristida intricata* S. T. Blake. Figs. 6-9, *Aristida exserta* S. T. Blake. Figs. 10-13, *Aristida platychaeta* S. T. Blake.

NOTES ON AUSTRALIAN CYPERACEAE, IV.

By S. T. BLAKE, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 27th November, 1939.*)

This paper deals with certain forms within the section *Isolepis* of the genus *Scirpus*. This intricate group includes a number of Australian species which, on account of the smallness of their parts and the general similarity in appearance are exceedingly difficult to distinguish, and are frequently found mixed in the same collection. In the citation of specimens, all of which have been personally examined, the herbaria in which they are laid are indicated by the abbreviations given below, and I here express my gratitude to the officials of these institutions for the loan of the collections in their charge.

Tate Herbarium, University of Adelaide	AD.
Herbarium of J. M. Black, Adelaide	BL.
Queensland Herbarium, Botanic Gardens, Brisbane	BRI.
Herbarium of J. B. Cleland, University of Adelaide	CL.
National Herbarium of Victoria, Melbourne ..	MEL.
National Herbarium of New South Wales, Sydney	NSW.

Where no special indication is given, the specimens are in BRI.

Scirpus laevis *S. T. Blake* sp. nov. (sect. *Isolepis*) inter species australienses distigmatosas spiculis subteretibus haud angulatis, glumis densis concavis incurvis 3–nervibus, nuce applanata fere laevi distinguenda. A *S. Brunoniano* S. T. Blake quem habitu nuceque admodum approximat, glumis spissis minus nervosis facillime deciduis differt.

Planta annua caespitosa viridis, usque ad 30 cm. alta. *Culmi* stricti, plerumque erecti, vivo teretes sicco applanati sulcati, glabri laevesque, usque ad 15 cm. longi, ca. 1 mm. lati, enodes vel nodo unico prope culmi basin sito. *Folia* ad vaginas 1–2 tenues sed firmas plurinerves antice hyalinas ore obliquo secto hyalino rubro-punctato mucronatas redacta. *Bractea* ima vel unica erecta, teres, culmo subaequilonga vel longior eum quasi continuans, apice acuta, basi hyalino-marginata rubro-punctata; secunda scariosa squamiformis, saepe florem abortivum fovens. *Inflorescentiae* dimorphae, altera exserta quasilateralis, altera basicaulis in vagina inclusa. *Inflorescentia exserta*: spiculae 1–4 digitatae sessiles vel ima brevissime pedunculata, ovoideae vel oblongo-ovoideae, subobtusae, teretes, multiflorae, 5–7 mm. longae, 2·2–2·7 mm. latae. *Rhachilla* exalata. *Glumae* densissimae, appressae, ovatae, acutae vel subacutae vel obtusae, apice subtriangulares muticae, concavae, sursum incurvae, dorso virides, 3–nerves nervo medio sub apice leviter incrassato, lateribus enervibus albo-hyalinae vel fulvo-tinctae, omnino glabrae, 1·7–1·9 mm. longae. *Stamina* 2, antherae minimae oblongae apiculatae 0·13 mm. longae. *Stylus* tenuissimus 0·2 mm. longus stigmata 2 longiora. *Setae hypogynae* nullae. *Nux* late obovata vel suborbicularis, minute apiculata, inaeque biconvexa valde applanata saepe fere planoconvexa, marginibus vix incrassata, minute reticulata vel ± laevis, nitide brunnea, 0·85–0·9 mm. longa, 0·7–0·75 mm.

lata, toro brevissimo. *Inflorescentia basicaulis* in vagina basali ad florem unicum redacta; stylus longissimus stigmatibus tribus longis exsertis; nux non visa.

WESTERN AUSTRALIA.—Kimberley Division: King River, October, 1906, *Fitzgerald* (NSW.).

CENTRAL AUSTRALIA.—Reedy Creek in 1894 *Tate* (*Horn Expedn.*) (AD.).

QUEENSLAND.—Cook District: Near Mareeba, in dried-out depressions in Eucalyptus forest, ca. 1,700 feet, March 28th, 1938, *Blake* 13483 (TYPE in BRI.). North Kennedy District: Between Townsville and Rollingstone in swamps, March 28th, 1933, *White* 8872.

Fairly easily distinguished by the long erect bract appearing as though a continuation of the culm, the non-angular spikelets, bifid style, and the rather thin biconvex or ± planoconvex nut. In a few instances only flowers in the basal leaf-sheaths were observed, but no nuts were seen. The styles in these flowers have *three* stigmas.

Scirpus setiformis *S. T. Blake* sp. nov. affinis *S. Oldfieldiano* S. T. Blake, sed habitu, glumis densis nucibusque minoribus praecipue differt. *S. arenarius* Benth. var. ? *setiformis* Benth. Fl. Austr. vii. 326 (1887).

Annua, densissime caespitosa, glabra laevisque. *Culmi* pernumerosi, obliqui vel erecti, stricti, setacei, compressi vel ± trigoni vel sulcato-angulati, usque ad 10 cm. alti, ± 0·25 mm. crassi. *Folia* non evoluta; vagina caulina unica, purpurea vel purpurascens, scariosa, leviter striata, arcta, usque ad 1·5 cm. longa, ore paullo dilatata, oblique acuminata, laminam 1–5 mm. longam angustissimam obtusam rarissime gerens. *Spicula* unica vel rarissime geminata, erecta vel interdum obliqua, fuscobrunnea, ovoidea, acuta, pluriflora, 3 mm. longa, 2 mm. lata, ebracteata vel gluma ima vacua saepe bracteiformis spiculam raro subaequans. *Glumae* (ima excepta) appressae, suborbiculares, obtusissimae, muticae, 9–13-nerves, obtuse carinatae, carina viridi 3-nervi haud vel vix excurrente, lateribus membranaceae, marginibus anguste scariosae, 1·6–2 mm. longae. *Stamina* 2, antherae oblongae apiculatae, apiculo usque ad 0·1 mm. longo incluso 0·3–0·4 mm. longae. *Stylus* 0·1–0·15 mm. longus, stigmata 2, ca. 0·8–0·9 mm. longa. *Setae hypogynae* nullae. *Nux* orbiculari-obovata, vix stipitata, apice subtruncata prominule apiculata, valde inaeque biconvexa vel subplanoconvexa, angulis tenuibus acuta vix costulata, tandem brunnea, laxiuscule reticulata, nitidula, interdum albida, subopaca, cellulis extimis minutis hexagonis marcidis, 0·8–0·95 mm. longa, 0·7–0·85 mm. lata.

WESTERN AUSTRALIA.—South-west Division: Near Perth, Nov. 1900, *Fitzgerald* (NSW., BRI.); Mount Barker, *Oldfield* (TYPE in BRI., MEL.).

Bentham l.c. suggested this form as a variety of his *S. arenarius* with doubt, pointing out it may be a distinct species. Under the circumstances it seems better to describe the form as a new species rather than a new combination.

Whatever *S. arenarius* Benth. may be, the name cannot stand because of the pre-existing *S. arenarius* Boeck. Hence I make the following change:—

Scirpus psammophilus *S. T. Blake* nom. nov. *S. arenarius* Benth. Fl. Austr. vii. 325 (1878), non Boeck. (1869-70.)

Bentham describes the species as having 2 style-branches, and it is so figured by Clarke (Ill. Cyp. tab. xlvii. figs. 1–2) from *Drummond* 360, which I have not seen. The Wilson's Promontory specimens however, have 3 stigmas, though otherwise they closely agree with Clarke's figure. Matching these specimens, but immature, are specimens collected by *Staer* at Middleton Beach, Western Australia, in Feb., 1911 (NSW.). Whether two closely similar species are involved, or whether there has been a mistake in the style branches (in all cases the nut appears to be plano-convex with a trace of a dorsal angle) can only be decided when Drummond's plants have been examined. It is unfortunate that this particular number should be missing from Herb. Melbourne, where most, at least, of Drummond's Cyperaceae seem to be represented.

Scirpus Oldfieldianus *S. T. Blake* nom. nov. *S. brizoides* Benth. Fl. Austr. vii. 326 (1878), non Willd. ex Link (1820).

Western Australia.—South-west Division: Pinjarrah, Oct., 1900, *Fitzgerald* (NSW., BRI.); Vasse River, *Oldfield* (MEL.); without definite locality, *Drummond* 919 (MEL., BRI., TYPE collection).

Chiefly distinguished by the solitary suberect loose-flowered spikelet with broad many-nerved glumes and the orbicular, thin and nearly flat nut.

Scirpus Brunonianus *S. T. Blake* nom. nov. *S. cyperoides* (R. Br.) Spreng. Syst. i. 208 (1825), non L. (1771), nec. Lam. (1778), nec. Hemsl. (1885). *Isolepis cyperoides* R. Br. Prodr. 222 (1810).

Western Australia.—South-west Division.

Scirpus australiensis (*Maiden & Betche*) *S. T. Blake* stat. nov. *S. cernuus* Vahl var. *australiensis* Maiden & Betche, Proc. Linn. Soc. N.S. Wales xxxiii. 316 (1908). *S. multicaulis* F. Muell. ex C. B. Clarke, Kew Bull. Add. Ser. viii. 29 (1908), nec Sm. (1800), nec Gmel. (1805), nec Schlecht (1847).

Queensland (Gregory South District), New South Wales, Victoria, South Australia.

Quite a distinct species. It differs sharply from *S. cernuus* Vahl in the nearly equally triquetrous nut with narrow costulate margins and from this and most other species in that the glumes are very thin, stoutly and acutely keeled, but with at most 1 nerve on each side. *S. congruus* (Nees) S. T. Blake has entirely nerveless sides to the glumes, but these are broader, and the nut is not costulate at the margins.

Scirpus calocarpus *S. T. Blake* sp. nov. (sect. *Isolepis*) affinis *S. setaceo* L. sed culmis tenerioribus, foliis haud evolutis eorum vaginis ore truncatis, spiculis minoribus, glumis minoribus minus nervosis apice plus patulis, nuce duplo minore differt. *S. setaceus* L. sec. Boeck. (partim), Benth., etc. non L.

Planta annua, caespitosa, viridis, glabra laevisque. *Culmi* pernumerosi, stricti, vel curvati, vel flexuosi, obliqui vel erecti, filiformes, crebre sulcati, usque ad 12 cm. longi, plerumque 0·2 mm. crassi. *Folia* haud evoluta; vagina caulina unica, tenuiter membranacea, pluristriata, purpurea, laxiuscula, inferne subinflata, ore ± hyalina truncata vel fere truncata, mucronata, mucrone raro in laminam angustissimam subplanam obtusiusculam usque ad 3 mm. longam producto. *Bractea* unica, erecta vel suberecta, spicula brevior, subglumiformis. *Spiculae* 1–2 sessiles, obliquae, ovoideae vel oblongae, obtusae, angulatae, 2·5–3·5 mm. longae,

1·5 mm. latae, pluriflorae. *Glumae* subdensae, facile deciduae, ovatae, obtusae, apice patulae, valde carinatae, praeter carinam robustam viridem valde curvatam vix excurrentem sed apice ipsa breviter excurvam tenuissime 4–6–nerves, nervibus saepe fere evanescentibus, lateribus tenuiter membranaceae hyalinae vel sanguineo- vel fusco-suffusae, 1·25–1·5 mm. longae. *Stamina* 3, antherae oblongae breviter apiculatae, 0·2 mm. longae. *Stylus* tenuissimus ca. 0·3 mm. longus, stigmata 3 fere duplo longiora. *Setae hypogynae* nullae. *Nux* brunnea vel fuscescens, nitens, fere globosa, basin versus saepe leviter attenuata, late stipitata, apice apiculata, indistincte trigona, longitudinaliter 10–12–costulata et transversim trabeculata ob cellulas extimas transversim oblongas distinctas, 0·6–0·7 mm. longa (toro incluso), 0·45 mm. lata.

QUEENSLAND.—Darling Downs District: Wyberba, in mud on the banks of a small stream, Jan. 19th, 1933, *Blake* 4542; Wallangarra, on dry bank of gully at roadside, Jan. 14th, 1933, *Blake* 4472.

NEW SOUTH WALES.—Without definite locality, *A. Cunningham* (MEL.). North-western Slopes: East of Barraba, on granite highlands, Nov. 20th, 1913, *Rupp* (NSW.); Warrumbungle Ranges, October, 1901, *Forsyth* (NSW.). Northern Tablelands: New England, *Perrott* 95 (MEL.), Jan., 1888, (MEL.). North Coast (or Northern Tablelands): Macleay River, *Bäuerlen* (MEL.). Central Western Slopes: Temora, Nov., 1916, *Dwyer* 952 (NSW.). Central Coast: Richmond, October, 1911, *Musson* (NSW.); Shell Harbour, October, 1899, *Cheel* (NSW.). Southern Tablelands: Bed of Lake George, 2,200 feet, Feb. 3rd, 1935, *Blake* 7557A; near Tharwa, Australian Capital Territory, on open swampy land, ca. 2,000 feet, Feb. 2nd, 1935, *Blake* 7544A (TYPE in BRI.).

VICTORIA.—Mallee: Swan Hill, in 1890, *Luehmann* (MEL.). Wimmera: Tankard's Waterhole, October 23rd, 1898, *Reader* (MEL.); Shire of Lowan, *D'Alton* 3 (MEL.). Western District: Near Mount William, *Sullivan* 22 pp. (MEL.); Skipton, on plains, *Whan* (MEL.). Central District: Near Ballarat, *Bacchus* 9 (MEL.); Yarra, in moist places, October, 1852, *Mueller* (MEL.). Gippsland: Waterloo, *Luehmann* (MEL.); Snowy River, *Mueller* (MEL.).

SOUTH AUSTRALIA.—Southern Districts: Bethany, April, 1875, *Mueller* (MEL.); Melrose, in damp spot, October 16th, 1915, *Black* (BL.); Wilpena Pound, Nov. 17th, 1882, *Tate* (AD.); Hog Bay River, Nov. 17th, 1883, *Tate* (AD.). Eyre Peninsula: Minnipa (AD.); Port Lincoln, Oct., 1933, *Dixon* (AD.).

WESTERN AUSTRALIA.—South-west Division: Bayswater, Nov., 1902, *Fitzgerald* (NSW., BRI.); Stirling Range, Nov., 1867, *Mueller* (MEL.).

TASMANIA.—Georgetown, Nov. 22nd, 1842, *Gunn* 421 p.p. (NSW.); South Esk River, near Perth, *Stuart* 232 (MEL.); without definite locality, *Mueller* (MEL.), and *Archer* 1587 (NSW., BRI.).

Much mixed in herbaria with *S. cernuus* Vahl, but readily enough distinguished in the mature state by the strongly carinate glumes and the structure of the nut. All the specimens seen are very similar to one another, and differ constantly from European specimens of *S. setaceus* L. hitherto seen in the characters given above.

Scirpus platycarpus *S. T. Blake* sp. nov. (sect. *Isolepis*) affinis *S. cernuo* Vahl sed glumis acutius carinatis apice patulis, nuce dorso haud

angulata, nitente, manifeste reticulata, cellulis extimis hexagonis majoribus differt.

Planta annua ? glabra laevisque. *Culmi* dense caespitosi, raro basi ramosi, tenuissimi, tenuiter striati, ± angulati, usque ad 8 cm. alti, plerumque 0·2–0·3 mm. crassi. *Folia* basalia vaginis scariosis purpurascentibus striatis coriacea, involuta, tenuiter striata, apice obtusiuscula, applanata ca. 0·5 mm. lata, usque ad 3 cm. longa, sed plerumque nulla; folia caulina plerumque ad vaginam unicam tenuem firmam striatam ore fere truncatam vel subtruncatam mucrone brevi erecto praeditam redacta, raro vagina in laminam setaceam applanatam coriaceam usque ad 4 cm. longam desinens. *Bractea* unica, subobliqua vel ± erecta, folio similis, usque ad 5 mm. longa, basi admodum dilatata glumiformis, caduca. *Inflorescentia* quasilateralis. *Spiculae* 1–2 ovato-ellipsoideae, obtusae, subteretes, pallidae vel castaneo-tinctae, 2·5–3·5 mm. longae, 2 mm. latae, multi- et densi-florae. *Glumae* membranaceae, late ellipticae vel suborbiculares, apice patulae vix mucronatae, manifeste carinatae, carina viridi 3–nervi curvata apice excurva, lateribus admodum opacae utroque nervis tenuibus ca. 4 notatae, marginibus anguste hyalinae, 1·5 mm. longae. *Stamina* 3, antherae breviter oblongae, prominule apiculatae, 0·3 mm. longae. *Stylus* tenuis 0·15–0·2 mm. longus, stigmata 3 fere 4–plo longiora. *Setae hypogynae* nullae. *Nux* suborbicularis vel orbiculari-obovata, minute apiculata, breviter lateque stipitata, subtrigona sed fere plano-convexa, angulis haud costatis dorsali evanescenti, brunnea nitensque vel opalescenti-albida, manifeste reticulata ob cellulas extimas hexagonas minusculas sed quam specierum aliarum multo majores, 0·75–0·8 mm. longa, 0·62–0·7 mm. lata.

New South Wales.—South-western Slopes: Albury, in 1890, *Wilson* (MEL.).

Victoria.—Wimmera: Lowan, Nov. 16th, 1892, *Reader* (TYPE in BRI., MEL.); Shire of Dimboola, March 10th, 1897, Dec. 2nd, 1887, Jan. 10th, 1892, *Reader* (MEL.); near Dimboola, Nov. 16th, 1892, *Reader* 4 (MEL.); near Dimboola, in inundated places, Feb. 7th, 1895, *Reader* 3 (MEL.). Western District: Near Mount William, Nov. 12th, 1873, *Sullivan* 22 p.p. (MEL.). Central District: Little Bendigo, near Ballarat, in 1875, *Day* (MEL.); near Dandenong Range, in 1891, *Dixon* (MEL.). Gippsland: Snowy River, Feb., 1905, *Grove* 1190 (NSW., BRI.).

South Australia.—Flinders Range: Wilpena Creek, Nov. 10th, 1928, *Cleland* (BL., BRI., CL.). Southern Districts: Bethany, *Behr* ? (MEL.); Reed Beds, Nov. 23rd, 1879, *Tate* (AD., BL.); Myponga, Jan., 1929, *Cleland* (CL.); Encounter Bay, Jan., 1924, *Cleland* (CL.), and in *Callistemon* swamp, Nov. 15th, 1935, *Cleland* (CL., BRI.); Encounter Bay, pond near Hall's Creek, Jan., 1933, *Cleland* (CL., BL.); Back Valley, Oct. 28th, 1936, and Jan., 1939, *Cleland* (CL.); south of Second Valley Forest Reserve, *Tate Soc. Expedn.*, Dec., 1938 (CL.); near Fulham, Jan., 1929, *Cleland* (CL.); Kangaroo Island: Harriet River, April 24th, 1923, *Davies* (BL.); Rocky River, Nov. 18th, 1924, *Cleland* (CL.); Hog Bay River (AD.). South East: Beachport (AD.). Yorke Peninsula: Southern Yorke Peninsula, Nov., 1889, *Tate* (AD.).

Western Australia.—South-west Division: Blackwood, in wet places, *Oldfield* 689b (MEL.).

Tasmania.—South Esk River, near Perth, in wet places, *Stuart* 232 (MEL.); Swanport, *Story* (MEL., NSW.); Hobart, Dec., 1893, and

Jan., 1894, *Rodway* (NSW.), and in Nov., 1923, *Lucas* (NSW., BRI.); without definite locality, *Archer* 1588 (NSW.), and *Mueller* (MEL.).

NEW ZEALAND.—North Island, Wellington Province: Foxton, wet hollows in sand-dunes, Jan. 1st, 1932, *Allan*.

In herbaria the specimens have been misidentified with *S. cernuus* Vahl and *S. calocarpus* S. T. Blake and at times were found mixed with the latter species. The spikelets externally resemble those of *S. calocarpus* rather closely by reason of the strongly carinate glumes spreading at the tips, the nut in its shape and size approaches that of *S. cernuus*, but the back is more rounded, the surface is glistening, while the external cells are larger and more prominent than in any other Australian species with cells of similar shape.

Some specimens in Herb. Melbourne were labelled by Reader as *S. riparius* var. *platycarpus* F. M. Reader, but I cannot find that this name was ever published or that any description was drawn up by him.

THE HELIOLITIDAE OF AUSTRALIA, WITH A DISCUSSION OF THE MORPHOLOGY AND SYSTEMATIC POSITION OF THE FAMILY.

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(*Read before the Royal Society of Queensland, 27th November, 1939.*)

(PLATES VI.–XI.)

CONTENTS.

I. Summary.

In this paper the Australian Heliolitidae are described. Only three genera occur in Australia—*Heliolites*, *Plasmopora*, and *Propora*. *Heliolites parvistella*, so important in Europe, is unknown in Australia, where the commonest species is *H. daintreei*, of which the European species *H. barrandei* is shown to be a synonym.

The genera of the Heliolitidae are reviewed, and from their morphology and micro-structure it is decided that the family is best regarded as a section of the Zoantharia Madreporaria, distinct from the Rugosa, Hexacoralla and Tabulata, but of equal rank to these sections. This section we call the Heliolitida.

II. Introduction and Terminology.

The terminology used for the Heliolitidae has depended on the systematic position assigned to them by the various authors, and as this has varied considerably some confusion has arisen. We define below, terms which can be applied to them without any implications on systematic position, or misapplications of terms used in other Anthozoa.

Tabularia.—The large tubes divided transversely by tabulae; the autopores of Nicholson; the calicular tubes, sometimes calicles, of Lindström; endothekalröhren of Kiär.

Reticulum.—The common tissue, sometimes vesicular, sometimes of polyhedric tubuli, between the tabularia; the coenenchyma of Edwards and Haime and Lindström.

Tubuli.—The small tubes of the reticulum; the siphonopores of Nicholson; the coenenchymal tubes of Lindström; exothekalröhren of Kiär.

Aureola.—The ring of tubuli, always twelve in number, which surrounds the tabularium in *Plasmopora*; aureola, corona, circlet of authors.

Testae.—The overlapping domed plates of the reticulum; the dissepiments of Edwards and Haime; vesicles of Nicholson; the convex laminae or lamellae of Lindström; blasen of Kiär.

Sola.—The transverse plates in the tubuli; the dissepiments of Edwards and Haime; the tabulae of Nicholson; the tabulae of the coenenchymal tubes of Lindström; boden of Kiär.

Commutation.—The coenenchymal gemmation of Lindström and others, whereby a number of tubuli give rise to a tabularium and *vice versa.*

Carina.—A flange on the side of a septum or wall.

III. The Genera within the Heliolitidae.

The earliest Heliolitids included both thickened and unthickened genera. The thickened forms all had their vertical skeletal elements very much dilated, the trabeculae being large and easily distinguished ("baculi" of Lindström); all loculi were practically filled by the thickening. Thus *Coccoseris megastoma* (McCoy, Lindström, 1899, p. 108, pl. xii., figs. 8-11) from the Caradocian Coniston limestone of Westmoreland is like a much thickened *Heliolites* with an infilled tubular reticulum; but in *Protaraea vetusta* (Hall,* Lindström, 1899, p. 111, pl. xii., figs. 19-24), another thickened form from the Trenton of America and Arctic America and the Wesenberg beds of Estland, the reticulum is almost absent. Kiär (1903, p. 12) regarded *Coccoseris megastoma* Lindström as belonging to *Acantholithus* Lindström, 1899; it seems to us that *Coccoseris* Eichwald (1860, genotype *Lophoseris ungerni* Eichwald, Lindström, p. 107, pl. xii., figs. 3-7) is congeneric with *Acantholithus* (genotype *Heliolites asteriscus* Roemer, Lindström, 1899, p. 113, pl. xi., figs. 31-35) the only difference being in the lesser dilatation of the vertical elements in *Acantholithus.* But we think it wiser to regard *Protaraea* as a separate genus since there is no good evidence that it has a tubular reticulum.

Propora Edwards and Haime (a genus with a reticulum consisting of testae, with spinose septa, and a more or less great development of discrete trabeculae throughout the tissue) appears to be the earliest of

* According to Troedsson (1928, p. 116) following Foerste, the Richmond specimens and the Scandinavian and Baltic specimens referred to *P. vetusta* by Edwards and Haime and by Lindström are not conspecific with *P. vetusta* Hall. Foerste proposed for them the new name *P. richmondensis.* Troedsson considered it probable that the true *vetusta,* thin sections of which have never been figured, was different generically from *P. richmondensis* and suggested that it might belong to *Protrochiscolithus* Troedsson. Bassler (1915, p. 1043), however, named *Porites vetusta* Hall non Edwards and Haime quite definitely as genotype of *Protarea,* by giving a bibliographic citation. Whether this selection should be maintained as valid, as against Troedsson's suggestion that the Richmond, Scandinavian and Baltic specimens (i.e., *P. richmondensis*) should be the type of *P. vetusta,* must be left until thin sections of the Trenton topotypes of *P. vetusta* Hall are figured.

the unthickened genera. An undescribed species occurs in the Caradocian Robeston Wathen limestone of Wales.

A form from the Trenton (?) of Arctic America (Iglulik Island) was described by Teichert (1937, p. 53, pl. iv., fig. 13; pl. v., figs. 1, 2) as *Plasmopora lambei* Schuchert, but judging by his figures and description it should be placed in *Propora,* with affinities to Edwards and Haime's species *P. conferta.* Troedsson's figures (1928, pl. 33, figs. 1a, b) of *P. lambi* Schuchert from the Cape Calhoun beds (Trenton or Richmond) of Greenland show a reticulum in which more than twelve radially elongate tubuli surround a tabularium, the walls of the tubuli frequently being discontinuous vertically. These Greenland specimens seem closer to *Heliolites* than to *Propora,* and it may be that they indicate a transition between the two genera. The specimens cannot be *Plasmopora* as there are more than twelve tubuli in the aureola. Another unthickened genus, *Protrochiscolithus* Troedsson (1928, p. 116, genotype *P. kiaeri* Troedsson *id.*), occurs in the Ordovician (Trenton or Richmond) Cape Calhoun beds of Greenland. It is like the central, unthickened portion of *Trochischolithus* Kiär, defined below, from the 5a and 5b beds of Norway. *Propora nummulosa* was described by Twenhofel (1928) from the Ordovician of Anticosti. Another Ordovician record is *Heliolites depauperata* Salter and Blanford (1865) from the Central Himalayas, of which we have seen neither description nor figure.

The greatest differentiation of the Heliolitids took place around the Baltic in the stages F1 and F2 of Estland, the *Leptaena* limestone of Sweden, and 5a and 5b of Norway*, followed by a world-wide development throughout the Silurian.

The unthickened genera *Proheliolites, Heliolites* and *Plasmoporella* made their first appearance in the F beds, the *Leptaena* limestone and/or the 5a beds, only the two latter and *Propora* continuing into later beds. *Proheliolites* Lindström (1899) is an unthickened form with little reticulum and, according to Lindström's description and figures, with septal spines directed proximally. *Heliolites hirsutus* Lindström (= *Nicholsonia megastoma* Kiär, 1899 = *Propora hirsuta* Kiär, 1903) is intermediate in some respects between *Heliolites* Dana and *Propora* Lindström, with a sparse reticulum like *Proheliolites* but with septal spines directed distally. *Heliolites* is also represented by two other species, *interstinctus* (Linnaeus) from the F of Estland and *parvistella* Roemer from the *Leptaena* limestone of Sweden, the F2 beds of Estland and the 5a and 5b beds of Norway. *Plasmoporella* Kiär (1899) (= *Camptolithus* Lindström, 1899) is like *Propora* but has highly domed tabulae and testae. Numerous species of *Propora* are abundant.

Of the thickened genera, *Coccoseris* and *Protaraea* which first occurred in the Ordovician persist to the end of this group of beds, when *Protaraea,* also known from the Richmond of North America, became extinct, while *Coccoseris* persists into the Valentian.

* The exact position of the boundary between the Ordovician and Silurian in the Baltic countries and North America is still under discussion, and the stage F of Estland, the *Leptaena* limestone of Sweden, the 5a and 5b beds of Norway and the Richmond of North America are placed by some in the Bala, by others in the Valentian. The position of the G1, G2, and H beds and the boundary between the Valentian and the Wenlock are also in doubt in the Baltic States. (See Troedsson, 1928, p. 181; O. T. Jones, 1928, p. 513; Ruger, 1934, p. 12; Reed, 1935, p. 371; Lamont, 1935, p. 303; Troedsson, 1936, p. 497).

Trochiscolithus (Kiär, 1903, genotype *Coccoseris micraster* Lindström, 1899 = *Palaeopora inordinata* (Lonsdale), Kiär, 1899), a genus sometimes massive, sometimes ramose, shows little thickening in the earlier portions of the colonies but much thickening elsewhere and has sparsely perforate walls and septa (see Kiär, 1903, pp. 13-29, figs. 1, 2 on p. 15; figs. 3, 4 on p. 17; figs. 5, 6 on p. 19; fig. 7 on p. 21). It is confined to this group of beds. The perforation of its walls was denied by Lindström, 1903, but is in our opinion definite and of the type seen in perforate Hexacorals, and not like the mural pores of *Favosites*. *Diploepora* Quenstedt which first occurred in these beds also is thin walled in the early stages, which closely resemble *Propora*, and thick in the later, but it is not perforate; it continued into the Ludlovian. *Palaeoporites* Kiär (1899, genotype *P. estonicus* Kiär, *id.*, p. 18) which is confined to this group of beds is highly perforate and thickened throughout; judging by Kiär's figures the trabeculae are rhabdacanthine and combine at the axis of the tabularium to form an axial structure, while the reticulum consists of tubuli with highly perforate walls.

The unthickened genus *Plasmopora* Ed. and H. (genotype *P. petaliformis* Ed. and H.) makes its first appearance with *P. stella* Lindström in G1 of Estland. It is like *Heliolites*, but the septa are continuations of the walls of the twelve tubuli around the tubularia, and the tubuli walls are usually discontinuous vertically. *Propora conferta* occurs in G1, G2, and H of Estland. Stratum *a* (*Arachnophyllum* bed) which is at or near the top of the Valentian in Gotland, contains *Coccoseris asteriscus* (highest record of this genus), and several species of *Propora*, *Plasmopora* and *Heliolites*, while *Cosmiolithus* Lindström (1899, which is like *Heliolites* but has tubuli of two sizes in the reticulum) makes its first appearance here. In Norway *Heliolites intricatus* Kiär and *Propora intercedens* Kiär occur in stage 6. *Plasmoporella* is figured (Yoh, 1932, p. 69) from the Valentian of China.

In Lindström's beds b-d of Gotland (= Wenlock of England) species of *Heliolites, Plasmopora, Propora,* and *Diploepora* are abundant, *Cosmiolithus* makes its last appearance and *Pycnolithus* Lindström (1899, genotype *P. bifidus* Lindström) occurs. This genus, founded upon one detached specimen from the shore near Visby but probably from b or c, has radially elongated tubuli with much thickened walls and bifid septa. In the Niagaran of America the genera *Heliolites, Plasmopora* and *Propora* are common and *Plasmoporella* Kiär (= *Camptolithus* Lindström) makes its final appearance. In beds e-h of Gotland (= Ludlow) species of *Heliolites* and *Plasmopora* occur, and *Propora* and *Diploepora* have their last occurrences. In Norway *Propora intercedens* occurs in stage 9. *Plasmopora* and *Propora* both occur in the Gotlandian of Korea (Shimizu, Ozaki, and Obata, 1934) and *Heliolites* in the Silurian of China (Grabau, 1925), and Indo-China (Mansuy, 1920). In Spiti, India, *Propora* occurs (Reed, 1912).

The variety of forms is greatly reduced in the Devonian though at certain localities particular species are very common. No Heliolitid is known later than the Givetian. *Heliolites* occurs throughout the Lower and Middle Devonian of Europe and is rare in the Devonian of America and Asia, while *Plasmopora* has been recorded from the Middle Devonian of the Carnic Alps, and Australia. *Paeckelmannopora* Weissermel (1939, p. 94, pl. 11, figs. 3-5) from the Gedinnian near Istanbul resembles *Plasmopora* in having tabularia with tabulae, and tubuli

with discontinuous walls and sola, but differs in that the tabularia have twelve longitudinal corrugations which Weissermel considers represent the septa, although no lamellae or spines are present; further the tubuli around each tabularium number more than twelve.

IV. The Microstructure of the Vertical Skeletal Elements.

(*a*) *The Trabeculae.*—The vertical skeletal elements are trabeculate throughout the family. Monacanths and rhabdacanths (Hill, 1936, p. 197) occur, though the latter are uncommon, being found only in *Plasmoporella papillatus* (Rominger), in *Palaeoporites* Kiär, and sporadically in individuals of several species of *Propora*, viz., *tubulata, conferta, speciosa,* and *bacillifera.* In the Heliolitida rhabdacanths are not associated with lamellar sclerenchyme as they are in the Rugosa. The walls and septa of *Heliolites* are of thin monacanths very closely packed except in the septa of *daintreei* and *porosus* where their axial parts are free spines. The inclination of the monacanths varies in the different species. In *interstinctus* they are inclined at an angle of 40° from the vertical; in the septa of *porosus* they make an angle of about 45°; in *daintreei* and its variety *spongodes* the septal spines are curved, and in the wall the monacanths are inclined at 30° from the vertical; in *parvistella* and its variety *intricatus,* and possibly in *fasciatus* the monacanths seem from Lindström's figures to be vertical in both septa and walls; in *liljevalli* it would appear that the monacanths in the walls are vertical but those of the septa are inclined at 30° from the vertical; in *repletus* the inclination is 20°. In *Cosmiolithus ornatus* the monacanths in the septa are inclined at 30°.

In *Plasmopora* also the septa and walls both consist of thin monacanths, whose inclination from the vertical is greater in the septa than in the reticulum. In this genus any monacanth may be extended laterally to form a carina, usually on one side only of a septum, occasionally on both sides; but the carinae* may be localised on the septa, in the aureola, or in the reticulum, and are yardarm or xyloid. In some species of *Plasmopora* the walls are vertically continuous as in *Heliolites,* but in many they are discontinuous and the monacanths are short and, while still arranged in vertical series, become normal to the curvature of the testae rather than keep their original inclination in the walls. These monacanths, normal to the testae, are the "aculae" of Lindström. The monacanths are of the order of 0·05 to 0·1 mm.

In *Propora* and *Plasmoporella* there are no continuous walls in the reticulum and the vertical skeletal elements consist of free trabeculae which are usually monacanths and are normal to the testae, are usually profuse and seldom in vertical series, and have a wide range in diameter and length. Lindström referred to the trabeculae under three names—"baculi," with radiating fibrous structure, a diameter of about 0·15 to

* Carinae may be parallel to the trabeculae or parallel to the growing edge of the septum. When parallel to the trabeculae they may be opposite—yardarm, e.g. *Heliophyllum* (see Hill, 1935, text figs. 15H, I.) or sub-opposite—xyloid, e.g. *Xylodes* (see Smith and Tremberth, 1929, pl. viii., figs. 3, 4) as seen in transverse section. When parallel to the distal edge of the septum they are cymatoid, e.g. *Cymatelasma* (see Hill and Butler, 1936, p. 522, text fig. 4). Yardarm and xyloid carinae are each formed by extensions of the fibres of one trabecula; cymatoid carinae on the other hand consist of a series of trabeculae. Xyloid and cymatoid carinae both make the septa appear zig-zag in transverse section.

0·2 mm. and a length of from 0·16 to more than 3 mm; "bacilli," in which he could observe no structure, with a similar diameter and length; and "aculae," very short and with a diameter of about 0·05 to 0·1 mm. in which he described no structure. In the septa the trabeculae are usually monacanths, and they are inclined as in *Plasmopora* and *Heliolites*.

Throughout the family Heliolitidae, thickened tissue consists of dilated monacanths, with the single exception *of Palaeoporites,* in which rhabdacanths are dilated. Both Lindström (1899, p. 104) and Kiär (1903, p. 37) considered that thickened genera arose from thin ones. It is difficult for us to form an opinion as we have not had the opportunity of examining specimens of some of the genera, but their view is contrary to our observations on other corals, in which in general, thickened forms give rise to unthickened.

Lindström and Kiär both consider that in *Proheliolites* the septal trabeculae are directed downwards at an angle of about 45° from the horizontal—a condition without a known parallel in the whole of the Anthozoa.

(*b*) *Discontinuity of the Vertical Elements.*—Whereas in *Heliolites* the walls in the reticulum are continuous both vertically and horizontally, in *Plasmopora* discontinuity occurs, such that segments of the walls stand on testae, each segment containing more than one monacanth. In transverse section these segments, combined with cut edges of testae, frequently give an appearance of complete tubuli. It is possible that a somewhat similar discontinuity seen in the tubuli walls in *Heliolites hirsutus* and in *Proheliolites dubius* may be connected in some way with the rapid change of the tubuli into tabularia and *vice versa*. As explained above the absence of walls in the reticulum of *Propora* is due to the complete and sometimes distant separation, one from another, of the individual trabeculae.

Perforation exactly similar to the perforation of the vertical skeletal elements in the perforate Hexacoralla and Rugosa, occurs in the Heliolitida, profusely in *Palaeoporites,* and rather rarely in *Trochiscolithus* and *Protrochiscolithus.*

V. Increase.

As in all compound coralla, the protocorallites of Heliolitid colonies must have arisen from planulae, after sexual reproduction. Lindström (1899, pp. 19-23, 45-47) distinguished three methods of asexual reproduction. His "coenenchymal" gemmation is well illustrated by his figures (1899, pl. i., figs. 21, 32, 33; pl. ii., fig. 37; pl. iii., fig. 27) and by those of Sardeson (1896, figs. 7-9), which show that tabularia may originate from a number of tubuli by the disappearance of the walls, and that also tabularia may be replaced by tubuli by the growth of dividing walls. This type of increase we propose to call commutation*; it possibly corresponds to differentiation and dedifferentiation in the soft parts, and may occur in Hexacorals such as *Turbinaria* (unpublished work by Edgar Riek, of the University of Queensland); a somewhat similar process takes place in the Alcyonarian *Heliopora* where a number of small "pores" give rise to a large "pore." Lindström's "intracalicinal" gemmation does not seem clear to us from his description and figures, and his "epithecal" gemmation may well be a special case of "coenenchymal gemmation."

* Commuto—to interchange.

Multiplication of the tubuli takes place by the growth of new divisional walls; a solitary carina may arise on any wall and by continued growth bisect the tubulus. This multiplication is similar to "fission" in *Chaetetes* and is quite different from the mode of increase in the Favositidae, which is intermural and at the angles. The growth of young corallites in *Favosites* is well illustrated in Jones (1936, text-figs. i.-xii.).

VI. Systematic Position of the Family.

(*a*) *Historical.*—The Heliolitidae have been classed at various times as Hydrozoa, Alcyonaria, Tabulata, Rugosa, Hexacoralla, a separate section of the Madreporaria, Tubocoralla, and as part of a new sub-class of Anthozoa, the Schizocoralla.

Linnaeus (*fide* Lindström, 1899, p. 38) made the first mention of a Heliolitid in literature, when (in 1745, p. 30) he referred a Gotlandian species to *Millepora*; but later (1767, p. 1276) he separated this species from *Millepora*, which has since been accepted as a Hydrozoan, and placed it with the corals, under the name *Madrepora interstincta*. Goldfuss (126, p. 64) likewise considered an Eifelian species to be a coral, *Astraea porosa.* Blainville (1830, p. 357) put this Devonian species in a new genus *Heliopora,* with *H. coerulea* of recent seas. Lonsdale (1839, p. 686) referred a number of Silurian species to *Porites* Lamarck. Dana (1848, p. 541) regarded the Palaeozoic and recent species of Blainville's *Heliopora* as distinct genera, and proposed *Heliolites* with type *Astraea porosa* Goldfuss for the Palaeozoic forms. About the same time McCoy recognised differences between the Palaeozoic and recent *Porites,* and proposed *Palaeopora* for the Palaeozoic species (1849, p. 129, no species mentioned; 1850, p. 276, only species mentioned, *Palaeopora subtilis**).

D'Orbigny also noted the differences between the Palaeozoic and recent forms and proposed for the former, first *Lonsdalia* (*fide* Lindström, 1899, p. 38) and later, probably because *Lonsdaleia* was pre-occupied, *Geoporites* (1850, p. 49). However, the priority of Dana's genus was quickly recognised and Edwards and Haime, in their classification of the Coelenterata (1850, p. lviii.) included Dana's genus in their new sub-order Zoantharia tabulata—corals in which the entire lumen is occupied by a tabularium, and in which the septa are rudimentary, and do not show a pinnate arrangement.

In 1876 Moseley recognised the Alcyonarian affinities of *Heliopora,* with which *Heliolites* has usually been compared. *Heliopora,* like the other Alcyonaria, has eight tentacles and eight mesenteries, the muscles being on the sulcar side of the mesenteries. Nevertheless, the skeleton of *Heliopora* is fibrous and trabecular as in the Madreporaria, not spicular like the rest of the Alcyonaria. Moseley regarded *Heliopora* as a dimorphic Alcyonarian, suggesting that the small tubules were modified zooids, siphonozooids, and the larger, autozooids. He accepted the affinity of the Heliolitidae with *Heliopora,* and concluded that all the Tabulata of Edwards and Haime were Alcyonaria; consequently, that the Heliolitidae were dimorphic. Nicholson (1875, p. 248) had previously expressed the view that *Heliolites* was dimorphic, and following Moseley's work, he placed this genus in the Alcyonaria (1879, p. 25).

* It is, however, doubtful if this species, which must be taken as the genotype of *Palaeopora,* is a Heliolitid.

These observations caused a flood of speculation on the possible Alcyonarian affinities of *Heliolites* and even of other genera of Edwards and Haime's Tabulata. Sardeson (1896) and Zittel (1900) followed Nicholson in placing *Heliolites* in the Alcyonaria. But Bourne (1895), after detailed studies on *Heliopora* concluded that neither was dimorphic, but that the coenenchymal tubules of *Heliopora* were part of a complex system of solenia. Nevertheless, he retained them in the Alcyonaria. Romer (1883, p. 500), Neumayr (1889, p. 326), Weissermel (1937, p. 93), and Wentzel (1895) considered the Heliolitidae to have no relation to the Helioporidae, leaving them as an isolated family of the Tabulata.

Lindström (1876, 1899a, 1899b) and Kiär (1899, 1903) have made outstanding studies on *Heliolites* and its allies. Lindström in 1876 (p. 15) placed *Heliopora* in the Alcyonaria but argued against any affinity between *Heliolites* and *Heliopora.* He created a special family for the former together with *Plasmopora* (including *Propora*), *Lyellia, Calapoecia, Thecostegites Halysites,* and *Thecia.* In 1899 he removed *Calapoecia, Thecostegites, Halysites,* and *Thecia* from the Heliolitidae and made two sub-families of the latter—the Heliolitidae with the genera *Heliolites, Cosmiolithus, Proheliolites, Plasmopora, Propora, Camptolithus, Diploepora* and *Pycnolithus,* and the Coccoseridae with the genera *Coccoseris, Protaraea,* and *Acantholithus.* He reiterated that he saw no affinity to *Heliopora* and no affinity with any other Palaeozoic corals. He did not discuss the possible affinity to the Hexacoralla. Kiär (1899, p. 49) considered the similarity of *Heliolites to Heliopora* to be homeomorphic only, and placed the Heliolitidae as a family of his Zoantharia Madreporaria (in which he appeared to include only Rugosa, Hexacoralla, and Heliolitidae). He thought them distinct from the "isolated group of the Tabulata." He gave a different grouping of the genera into sub-families.

Some authors—e.g. Gerth (1908)—have pointed out the morphological similarity between the Heliolitidae and many of the Hexacorals (especially *Seriatopora, Stylophora and Pocillopora*), and have regarded the former as the ancestors of the latter. The genera which Gerth studied were those grouped as the Madreporaria Tubocoralla by Steinman (1907). Zittel (1900) placed the Heliolitidae in the Alcyonaria. Woods (1926) considered that the systematic position of the "Tabulate Corals," in which he placed the Heliolitidae, was not yet satisfactorily established. Okulitch (1936) recently united the Heliolitidae with the Tetradidae and Chaetetidae in a new subclass, the Schizocoralla, the diagnostic characteristics being given as (1) increase by fission and (2) absence of true septa. But, in the Heliolitidae, only the tubuli of the reticulum increase by fission and true septa are present. Weissermel (1937, p. 93), in a review of Okulitch's work, criticised his grouping of families and summarised the evidence for regarding the Heliolitidae as Tabulata, which he considered a valid group.

(*b*) *Comparison with Other Groups.*—The elucidation of the affinities of the Heliolitidae is rendered all the more difficult as their soft parts are quite unknown, whereas three of the groups to which they have been referred are classified on soft parts almost entirely; further the relationship of the hard parts to the soft parts in groups where both are known is not always made clear by writers. Again, structural similarities in forms of such widely separated ages as Devonian and Present are very likely to be due to homeomorphy, not to generic affinity, when no clear links are known.

(1) *Alcyonaria.*—

The Alcyonaria are Actinozoa with eight mesenteries and eight pinnate tentacles; the stomodaeum has a single siphonoglyph (ciliated groove); the skeleton is internal, consisting of spicules in the mesoglaea, occasionally supplemented by an external skeleton; the longitudinal muscles are on the ventral faces of the mesenteries (Potts, p. 180, in Borradaile and Potts, 1935).

The Alcyonarian with which *Heliolites* has been frequently compared is *Heliopora* Blainville (Plate XI., fig. 6). Its soft parts leave no doubt that it is Alcyonarian; but, were the skeleton alone known, it would almost certainly be placed with the Madreporaria, being trabeculate like that of the Madreporaria, not spicular as in other Alcyonaria. Each trabecula consists of fibres directed upwards and outwards. Both skeletons consist of two sizes of vertical tubules, both of which are divided by horizontal plates. A detailed comparison, however, immediately brings out important differences. In *Heliopora* one to five vertical trabeculae occur massed together to form a pillar at the point where more than two tubules meet, and the walls between the tubules consist of continuations of fibres from the pillars at the corners. There is never a trabecula in the wall between two tubules, they are always massed at the point of junction of three or more.* The "pseudosepta" of the tubes consist of several vertical trabeculae, so closely placed in series that their fibres cannot be differentiated. In *Heliolites* the wall between two tubuli does not differ in structure from the wall at the point of junction of more than two tubuli; the walls consist everywhere of trabeculae, curved, inclined, or rarely vertical, the fibres of the trabeculae radiating obliquely upwards and outwards. The septa have a similar structure to the walls, being built up of a number of curved or inclined trabeculae. Thus in *Heliolites* the septa and walls consist of regularly spaced trabeculae, usually inclined, while in *Heliopora* all the trabeculae are vertical, and in the "coenenchyma" are massed into pillars at the point of junction of three or more tubules.

In *Heliolites* the trabeculae of the septa may be in contact, so that the septa are lamellar as in *H. parvistella*, or free axially—i.e. acanthine —as in *H. daintreei*. Both monacanthine and rhabdacanthine types (Hill, 1936, figs. 14, 15) occur, but in *Heliopora* the trabeculae of the "pseudo-septa" are always in contact so that the "pseudo-septa" are always lamellar and never spinose. Many writers have considered that the radial plates of *Heliopora* differ from the "true septa" of the Rugosa and Hexacoralla and hence have termed them "Pseudosepta." It is difficult to discover in their writings any clear reasons for this differentiation, which appears to be based on the idea that the septa of the Rugosa and Hexacoralla arose later than, and independently of, the "theca" (i.e., the wall), whereas the "pseudosepta" of *Heliopora* are continuations into the tabularium of the walls of the small tubes and thus are an integral part of the walls. This argument is based on a misunderstanding of the micro-structure of the skeleton and of the manner in which it was formed by the soft parts. It is clear from the description and figures above that the radial plates in both *Heliopora* and *Heliolites* have a trabecular structure as in the vertical skeletal elements of all Rugosa and Hexacoralla; but whereas in *Heliopora* the

* This differs somewhat from the micro-structure described and figured by Bourne (1899, pp. 517-524, figure on p. 523).

septal trabeculae are vertical, in *Heliolites*, as in the Rugosa and Hexacoralla, they are inclined. We remain in doubt if this difference is sufficient to justify the use of the prefix "pseudo."

In the Anthozoa much classificatory importance has been attached to the mode of insertion of the septa, and the number, insertion, and arrangement of the mesenteries. Thus the Rugosa are distinguished by the pinnate insertion of the septa (in fours) and the Hexacoralla by the cyclical insertion of the septa and mesenteries, the cycles being six or multiples of six. Hickson (1924, pp. 31, 32) has suggested that the Hexacoralla may be divided into two groups—group B, one in which twelve mesenteries are developed—and the other, group A in which more than twelve appear. When small numbers of mesenteries are involved the number of septa usually corresponds to the number of mesenteries, but such a correspondence is not invariable when the numbers are large. In the Actinians no such easy generalisation in number of mesenteries and septa can be made.

The Alcyonaria are distinguished by eight mesenteries. In *Heliopora* while there are always eight mesenteries, the number of septa (or pseudosepta) varies but is usually between ten and sixteen (according to Lindström, sometimes seventeen) although according to Moseley the most common number is twelve. *Heliopora* is apparently the only Alcyonarian with radial vertical plates which might be compared with septa. This lack of correspondence in the number of septa and mesenteries has also been used as an argument for terming them "pseudosepta," but it appears to us possible that they represent two incomplete cycles of eight. It should be kept in mind that little is known regarding the insertion of septa in hystero-corallites of compound Rugosa and Hexacoralla, but it seems possible that the basic plan of insertion might be masked in such types (e.g., see Smith and Ryder, 1927, pp. 339-342, text fig. 2).

In the Heliolitidae, when septa are present they are invariably twelve in number. There is a strong contrast here with the variability in *Heliopora*; and the fixity of twelve in the Heliolitidae suggests comparison with the Madreporaria rather than the Alcyonaria and in particular with Hickson's Group B of the Hexacoralla (1924, p. 32).

The question of dimorphism in *Heliopora* is one which has been much discussed since first postulated by Moseley (1876) but it still remains unsettled, some text-books following Moseley's theory of dimorphism, others adhering to the views of Bourne (1895) that the "coenenchyme" viewed by Moseley as siphonozooids is in reality a complex system of solenia (i.e. a canal system with extensions downwards into the small tubes but no openings to the free surface). Nicholson (1879, p. 25) and others, accepting dimorphism in *Heliopora*, argued by analogy that *Heliolites* was dimorphic, and therefore, an Alcyonarian. Professor Hickson, the British authority on Alcyonaria, says (*in litt.*): "As regards the dimorphism of *Heliopora*; it is not dimorphic and there is no clear evidence that it ever was dimorphic." Accepting this view of Bourne and Hickson, Nicholson's argument based on dimorphism is invalid.

Thus we consider the Heliolitidae differ from the Alcyonarian *Heliopora* in the general arrangement of the trabeculae, and in having a fixed number (12) of septa; and that for the same reasons they cannot be Alcyonaria.

(2) *Zoantharia.*—

The Zoantharia are Anthozoa with mesenteries varying greatly in number, typically arranged in pairs, the longitudinal muscles of which face each other except in the case of two opposite pairs, the *directives*, in which the muscles are on opposite sides; the tentacles are usually simple, six or some multiple of six in number, and the mesenterial filaments are trefoil-shaped in section; the stomodaeum has two ciliated grooves; typically there is a calcareous exo-skeleton, but this may be entirely absent.

The Zoantharia are divisible into the Actinaria (sea anemones) which are usually single individuals always without a skeleton, and the Madreporaria, usually colonial, always with an ectodermal exo-skeleton.

To the present-day biologist, the Hexacoralla are Madreporarian, but the soft parts of Rugosa and Tabulata being unknown, these sections are given but little space in zoological classifications. To Edwards and Haime, the Rugosa and Tabulata were also Madreporarian. Not knowing the soft parts of Rugosa and Tabulata, we cannot be sure that they are Madreporaria, but the possession of an exo-skeleton which is trabeculate, septate and tabulate, as in the Hexacorals, indicates affinity with the Madreporaria. The Rugosa, Hexacoralla, and Tabulata will all be included herein as sections of the Madreporaria.

(*a*) *Hexacoralla.*—Madreporaria in which the pairs of mesenteries and the septa are inserted in cycles which are six or multiples of six.

In the Heliolitidae we have no information on the mesenteries; but in both Heliolitidae and Hexacoralla all the vertical skeletal elements consist of vertical series of curved, inclined, or rarely vertical trabeculae. The septa of Heliolitidae are constantly twelve, and there is a group of Hexacoralla recognised by Hickson (1924, p. 32) in which the septa number six or twelve; in this group, however, when twelve occur, they are divisible into a primary and secondary cycle, according to their length and period of insertion. In the Heliolitidae there is no good evidence that the twelve septa are divided into two cycles, although Lindström (1899, p. 55) has suggested that such is possible in *H. porosus*.

In the Heliolitidae there is a reticulum which may consist of trabeculate polyhedric tubes crossed by sola, or of testae supplemented by further free trabeculae. In the Hexacoralla a common tissue frequently occurs; it may consist of dissepiments supplemented by trabeculae, as in *Cyphastraea*, or of dilated trabeculae as in *Pocillopora* and *Stylophora*, which both belong to Hickson's group characterised by six or twelve septa; or it may be compact or spongy.

Thus there is very close morphological similarity between the Heliolitidae and Hickson's group B, but absolute identity is spoiled because the twelve septa of the Heliolitidae are not divisible into two cycles of six.

(*b*) *Rugosa.*—Madreporaria in which there are two series of septa inserted pinnately on a tetrameral plan. The soft parts are unknown.

The vertical skeletal elements of the Rugosa consist, like those of the Hexacoralla and the Heliolitidae, of vertical series of curved or inclined trabeculae. The septa of all adult corallites alternate in size, their insertion being pinnate, on a tetrameral plan (Hill, 1935, p. 504). It may be that in hystero-corallites the pinnate manner of insertion is

masked, but nevertheless, the alternation in size of the septa is always visible. In the Heliolitidae the manner of insertion has not been investigated, and any results obtained by such an investigation could not be used for comparative purposes until the insertion of septa in the hystero-corallites of Rugosa and Hexacoralla is also known. But in the Heliolitidae there is no good evidence that the septa alternate in size.

In the Rugosa the arrangement of plates in plocoid coralla suggests corallites surrounded by common tissue, but the "corallites" are in this case the tabularia, and the "common tissue" the dissepimentaria; whether the reticulum of *Heliolites* also represents dissepimentaria depends on the possibility that minor septa are present in the Heliolitidae; for in the Rugosa the development of dissepiments is dependent on the presence of minor septa. But the evidence that minor septa occur in Heliolitidae is weak, and therefore, the evidence that the reticulum of the Heliolitidae is homologous with the "common tissue" of Rugosa is also weak. Nevertheless, Lindström considered this a strong possibility. His reasons were (1) that in one specimen of *H. interstinctus* (1899, pl. 1, figs. i.-iv.) he observed a single corallite with two "thecae," one enclosing what we propose to call the tabularium and one enclosing this and some "coenenchyma." But at a later stage the outer "theca" encloses a great number of "calicles" and becomes in fact the wall of the whole colony, or holotheca. He drew an analogy between the inner wall and the wall* in the dissepimentarium of *Acervularia*. (2) In some of the Heliolitidae from Gotland he observed

* *Walls in the Rugosa.*—Much confusion has arisen in the use of terms for walls in this group mainly because the method of formation of the skeleton was not understood by the earlier writers. A review of the terms used for the various walls in Madreporaria has already been made (Hill, 1935, pp. 497, 499, 508, 512); and the definitions given below are in amplification.

Epitheca and Holotheca.—In simple corals the term *epitheca* is applied to the sheath enclosing the whole of the lumen and situated immediately outside the peripheral ends of the septa; in compound corals it is applied in a similar manner to the sheath surrounding each corallite when the corallites are separable; *holotheca* is applied to the sheath surrounding the whole colony. Immediately inside the epitheca in Rugosa is a narrow *peripheral stereozone* (see below) which is fibrous, though not certainly trabeculate in structure, while the epitheca and holotheca probably are granular. Usually the peripheral stereozone is very narrow and has then been regarded as part of the epitheca, but in such a case it seems better to refer to the double structure as the *outer wall.*

It is, however, not certain that the epitheca and holotheca are separate structures. The holotheca may be but the sum of the epithecae over the outer parts of the peripheral corallites; further miscroscopic examination of conditions in massive coralla with inseparable and separable corallites is needed. Until this is done, we propose to continue using the two terms as defined above.

Peripheral Stereozone.—A stereozone (trabeculate or merely fibrous) of any width, at the periphery of a corallite.

Median Stereozone.—A new phrase to describe any stereozone which is within the dissepimentarium but does not extend to the periphery, e.g. the "inner wall" of *Acervularia.* It may be produced either by dilatation of the septa ("pseudotheca" of Heider, see Ogilvie, 1897) or by the growth of additional trabeculae between the septa ("eutheca" of Heider, see Ogilvie, 1897).

Wall of the Tabularium.—This is not a separate strucure but is the junction of the dissepimentarium and the tabularium.

Wall of the Axial Structure.—This also is not a separate part, being the junction of the axial structure with the outer tabulae.

Aulos.—A distinct wall within the tabularium; a tube enclosing almost flat tabulae, and surrounded by inclined tabulae; supposed to have been formed either by down turning of the axial parts of the tabulae or by the conjunction of the curved axial ends of the septa. In the first case the micro structure of the aulos is that of the horizontal skeletal elements and in the second that of the vertical skeletal elements.

faint polyhedric markings in the coenenchyma suggestive of "outer walls" of the calicles. But Lindström's "inner theca" in *Heliolites* is the wall of the tabularium and his "outer theca" is the holotheca, and thus his first analogy with the Rugosa is invalidated. As for his second argument the faint polyhedric markings in the reticulum were observed on the weathered surface only of a few specimens and might equally well be explained as differential weathering.

Thus there being no good evidence of two orders of septa, and no evidence that the reticulum is a dissepimentarium, and Lindström's analogies on the walls being invalid, we conclude that there is no reason to place the Heliolitidae in the Rugosa.

(*c*) *Tabulata*.—The sub-order Tabulata was founded by Milne Edwards and Haime for a group of compound corals in which the septa are absent or rudimentary and the tabulae well developed.

The soft parts of both the Tabulata and Heliolitidae are unknown. In the Tabulata septa may or may not be present, but when present they are always rudimentary. This also applies to the Heliolitidae, but the constant number of twelve characteristic of the Heliolitidae is very rarely exhibited by the Tabulata, in fact, in the latter the number appears to be extremely variable.*

The micro-structure of the skeleton is similar—i.e. trabeculate with the trabeculae curved or inclined. In neither are dissepiments developed, unless the reticulum of the Heliolitidae is a dissepimentarium (see argument under Rugosa). In both, tabulae are well developed. Mural pores, hollow connecting processes or solid platforms are present in most but not all genera of the Tabulata, but not in the Heliolitidae.

The question whether the Tabulata is a natural group remains an open one in spite of detailed discussions by more than one author. But even if it is, the Heliolitidae cannot in our opinion be included in it with the Favositidae, for the constant number of septa, as opposed to the great variability in the Tabulata, the absence of mural pores or connecting processes, and the presence of a reticulum in the Heliolitidae are sufficiently important characters to separate them.

C. Conclusion.

To sum up, the Heliolitidae are not Alcyonaria, because the number of septa is fixed at twelve. Their skeletal morphology however indicates that they are Zoantharia Madreporaria. They are quite dissimilar to the Rugosa or the Tabulata in this septal fixity, but they might perhaps be placed in the Hexacoralla with the Seriatoporidae and Madreporidae. There is however no good evidence that their twelve septa are inserted

* The number may be fixed in some Tabulata but this is not yet proved and is difficult of proof, as. e.g. in *Favosites*, it is nearly impossible to get a transverse section which is exactly at right angles to the direction of growth of the corallites, and, the septa being spinose, a complete cycle would rarely, if ever, appear in any one section. This difficulty increases when the septal spines are flat and widely spaced vertically. The only Tabulata known with lamellar septa—*Fossopora*, Etheridge (1903, p. 16) and *Angopora* Jones (1936, p. 18)—have six and "about twelve" respectively. *Angopora* is possibly related to *Thecia* Ed. & H., in which however, the septa are much thicker, and to *Favosites hisingeri* group 111, Tripp (1933, pp. 114-5, text fig. 33), non Ed. & H., in which about twelve short lamellar septa are seen in the text figure. *Favosites tripora* Walkom has twelve vertical series of septal spines in each corallite.

TABLE I.

SUMMARISING AND COMPARING THE STRUCTURE OF CERTAIN CORALS.

—	Heliolitida.	Alcyonaria (*Heliopora*).	Hickson's Group B of Hexacoralla (Seriatoporidæ and Madreporidæ).	Rugosa.	Tabulata.
Mesenteries	?	8	6 pairs	?	?
Micro-structure of skeleton	curved, inclined or vertical trabeculæ	vertical trabeculæ	curved, inclined or possibly sometimes vertical trabeculæ	curved or inclined trabeculæ	curved or inclined trabeculæ
Perforation of the skeleton	in three genera only ..	not known	in one family only	in one family only	in several genera
Septa	12, one cycle (slight possibility of two cycles in *H. porosus*)	10–16, not arranged in cycles	6 (one cycle) or 12 (two cycles of 6)	alternate in size (major and minor) number varies with size of corallite	very variable in number even in different parts of the same corallite; no cycles recognisable
Reticulum	tubuli with sola, or testæ ..	trigonal or tetragonal tubes with transverse plates	compact, or spongy ..	None unless the dissepimentarium is such	none except possibly in *Halysites*
Dissepimentarium	none unless the reticulum is such	none	none	well developed	none
Tabulæ	well developed	well developed	well developed	well developed	well developed
Mural Pores	absent	absent	absent	absent	well developed in almost all
Connecting Processes ..	absent	absent	absent	in some genera	in some genera

in cycles of six, which is the chief diagnostic character of the Hexacoralla. The insertion and arrangement of the septa is of primary importance in the sub-division of the Madreporaria, and it seems to us that the fixed number 12 and the equality of these 12 septa denotes a section of the Madreporaria equally as distinct as the Rugosa or the Hexacoralla. For this section we propose the name Heliolitida.

The Anthozoa would then be sub-divided as follows:—

Class.	Order.	Sub-order.	Section.	
Anthozoa	*Zoantharia*	*Madreporaria*	*Rugosa*	
			Hexacoralla	Group A
				Group B
			Heliolitida	
			(*Tabulata*)	
		Actinaria		
	Alcyonaria			

This is essentially what Kiär (1903) proposed. Brackets are placed around the Tabulata as they may not be a natural group.

VII. Systematic Descriptions.

ZOANTHARIA MADREPORARIA HELIOLITIDA.

Family HELIOLITIDAE.

Typical Genus: *Heliolites* Dana.

Diagnosis.—Compound corals with tabularia each defined by a wall usually ridged by septa which, when present, always number twelve: the tabularia are separated by a reticulum of tubuli or testae; the tabularia and tubuli are transversely divided; dilatation of the walls of the tubuli and of the septa may suppress the walls of the tabularia and the transverse plates; carinae may occur.

Range.—The Heliolitidae first appear in the Upper Ordovician of Europe and North America; they are common in the Silurian of Europe, North America, China, and Australia; and die out at the end of the Middle Devonian.

Remarks.—Lindström (1899) and Kiär (1903) have suggested different groupings into sub-families of the genera in the Heliolitidae. Both classifications were necessarily based chiefly on morphology, but partly also on assumed phylogenetic lines, Kiär's arrangement giving a greater importance to his views on phylogeny. Thus he considered that the thickened genera arose from thin ones, and grouped those genera which are similar except for thickening into sub-families. The present writers consider it profitless to attempt a grouping of the genera of Heliolitidae into sub-families on the evidence at present available to them.

Variability.—Individual species of Heliolitidae may vary within wide limits, in many characters. Thus the width of tabularium varies between 1 mm. and 3 mm. in *Heliolites interstinctus*. The distance apart

of the tabularia is most variable in *Propora tubulata* and *Propora conferta*, being sometimes six times as great as others. Septal spines in some corallites of *P. tubulata* may be two and a-half times as long as those in others. The extreme example of the shortening of the septal spines is found in *H. interstinctus*, where this, the *decipiens* trend, has given rise to the variety *decipiens* in which the septa are absent and even the crenulations in the walls of the tabularia are lost, leaving the walls cylindrical. In some species, especially in the genus *Propora*, rhabdacanths may be sporadically developed in the septa, instead of the usual monacanths. The dilatation of the vertical skeletal elements may be six times as great in some individuals as in others of the same species, e.g. *Propora conferta*.

Genus *Heliolites* Dana.

Heliolites Dana, 1846, p. 541.

Lonsdalia D'Orbigny, 1849, p. 12 (vide supra, p. 189).

Geoporites D'Orbigny, 1850, p. 49 (vide supra, p. 189).

Stelliporella Wentzel, 1895, p. 27; genotype (by designation) *S. lamellata loc. cit.*, p. 34, pl. iv., figs. 10-12; E2, Kozel, Bohemia (? = *Heliolites parvistella* Roemer).

Pachycanalicula Wentzel, 1895, p. 27; genotype (by designation) *H. barrandei* Hoernes, MS., in Penecke, 1887, p. 271, Taf. xx., figs. 1-3.

Nicholsonia Kiär, 1899, p. 37; genotype *Heliolites megastoma* Kiär (*loc. cit.* and pl. vi., figs. 8, 9, pl. vii., figs. 1, 2) non McCoy (= *H. hirsutus* Lindström, 1899, p. 64). Non *Nicholsonia* Waagen and Wentzel, 1866, which is *Escharopora* Hall, 1847. a Polyzoan.

Helioplasma Kettnerova, 1933b, p. 180; genotype (by monotypy), *H. kolihai* Kettnerova, *loc. cit.* p. 182, text figs. 1, 2. Lower Devonian, Bohemia.

Genotype.—*Astraea porosa* Goldfuss, 1826, p. 64, pl. xxi., fig. 7. Devonian. Eifel.

Diagnosis.—Heliolitida with tabularia each defined by a wall usually ridged by septa which number twelve; the tabularia are separated by a reticulum of tubuli; tabularia and tubuli are transversely divided by complete tabulae and sola respectively.

Range.—F_1 to Middle Devonian in Europe; Niagaran to Devonian in America; Silurian and Devonian in Asia; Silurian and Devonian in Australia. *H. depauperata* is recorded from the Ordovician of the Central Himalayas by Salter and Blanford, 1865, but we have seen neither description nor figures.

The species of *Heliolites* are long ranged. The *interstinctus* group (*H. interstinctus*, *H. fasciatus*, and *H. repletus*), which is characterised by tabularia with short lamellar septa with entire axial edges, by polygonal tubuli variable in number and by the frequent occurrence of a columella, first occurs in F_1 of Estland, and continues to the Middle Devonian. The *parvistella* group (*H. parvistella* and *H. liljevalli*, characterised by tabularia with lamellar septa reaching to the centres where they form an irregular network) extends from F_1 to the end of the Silurian. *H. daintreei* (characterised by septa which are long but axially are broken into numerous upwardly directed trabeculae, which may form a network) is first found in the Upper Valentian (Lindström's a of Gotland) and continues to the Middle Devonian: *H. hirsutus* (with a sparse discontinuous reticulum and upwardly directed septal spines) is confined to Stratum a of Gotland; *H. porosus*

(with thick-walled tabularia and septa which are variable in length, spinose axially and sometimes alternating in size) is known only from the Lower and Middle Devonian.

Remarks.—We agree with Lindström (1899, p. 62) and Kiär (1899, p. 40) that *Stelliporella lamellata* is closely related to *Heliolites parvistella* if not identical with it and as we retain *parvistella* in the genus *Heliolites, Stelliporella* is a synonym of the latter. Wentzel (1895, p. 27) made *H. barrandei* the type of a new genus *Pachycanalicula.* Wentzel based this on specimens from Bohemia with thick walled tubuli; Lindström examining both Swedish and Bohemian specimens found that the Bohemian individuals had thicker walls, but considered this to be due to compression of the specimens. Kiär (1899, p. 43) considered the degree of thickening of the walls not to be of generic significance.

H. hirsutus, the type of *Nicholsonia* (which is in any case preoccupied) we place in the genus *Heliolites.* Although it resembles *Proheliolites* in having a sparse reticulum, the septal spines are directed distally as in *Heliolites.* There is a resemblance to *Propora* in cross section, but this is due solely to the discontinuity of portions of the tubuli walls, whereas in *Propora* tubuli are completely absent, the only vertical structure being single trabeculae. This discontinuity, which is very rare in *Heliolites,* may be a reflection of the rapid replacement of tubuli by tabularia. The horizontal elements in the reticulum are sola, not testae. As there are more than twelve tubuli surrounding each tabularium, this species cannot be referred to *Plasmopora.*

Helioplasma was founded for Bohemian specimens differing only slightly from normal *Heliolites.* The differences (the occurrence in parts of the reticulum of testae instead of sola, and a very slight discontinuity of the tubuli walls) is insufficient in our opinion to justify separation from *Heliolites.* Kettnerova considered the species intermediate between *Heliolites* and *Plasmopora* but it has not an aureola of twelve tubuli as is characteristic of *Plasmopora.*

The only well-defined trend we have observed in *Heliolites* is the "decipiens" trend, by which the walls of the tabularia lose their septa and septal crenulations. This is common and was fully described and illustrated by Lindström (1899) in *Heliolites interstinctus,* but it also acts in other species. The trend is developed unequally in different parts of the same corallum (see Lindström).

Heliolites daintreei Nicholson and Etheridge.

(Pl. vi., figs. 1-5; pl. vii., figs. 1-5; pl. viii., figs. 1-8; pl. ix., fig. 1.)

Heliolites Daintreei Nicholson and Etheridge, 1879, p. 224, pl. xiv., figs. 3, 3a. Broken River, North Queensland. Devonian.

Heliolites plasmoporoides Nicholson and Etheridge, 1879, p. 225, pl. xiv., figs, 2, 2b. Broken River, North Queensland. Devonian. Lectotype (here chosen) 90246, British Museum (Natural History).

Heliolites Barrandei R. Hoernes *nom. nud.*, Penecke, 1887, p. 271, pl. xx., figs. 1-3; top of Lower Devonian of Graz, Austria. Type material: Kettnerova, 1932, p. 6, pointed out that Penecke's syntypes were lost at the University of Czernowitz in the War 1914-1918. She based her work on Penecke's material at the Geological Institute of Graz University. As we have not access to this, we are unable to choose a neotype and we accept Lindström's interpretation of the species.

Heliolites Daintreei; Jack and Etheridge, 1892, p. 61, pl. i., figs. 7, 8.

Heliolites plasmoporoides; Jack and Etheridge, 1892, p. 62, pl. i., figs. 9-11.

Pachycanalicula Barrandei; Wentzel, 1895, p. 27.

Heliolites Barrandei; Lindström, 1899, p. 58, pl. iii., figs. 8-12, 17-27.

? *Heliolites interstincta* (Linnaeus); Chapman, 1913, p. 222 [Devonian], Lilydale Limestone, Victoria.

non *Heliolites interstincta* var. *gippslandica* Chapman, 1914, p. 311, pl. lx.; from the Silurian (possibly Devonian) of Cooper's Creek, Thompson River, Victoria (specimens not examined. This is *Plasmopora*, see p. 206).

? *Heliolites interstincta* var. *gippslandica* Chapman, 1920, p. 185, pls. xxix., xxx.; Silurian, Cowombat Creek, Victoria (specimens not examined).

Heliolites yassensis Dun, 1927, p. 255, pl. xviii., fig. 1; Yass District, N.S.W.; upper Silurian. Lectotype (here chosen) the specimen in the Australian Museum F5176 with two sections, A.M. 62, from Hattons Corner, Yass, figured by Dun *loc. cit.*

Heliolites regularis Dun var. *humewoodensis* Dun, 1927, p. 257, pl. xviii., figs. 4, 5; upper Silurian. The syntypes including the specimen figured are lost.

Heliolites jackii Dun, 1927, p. 257, pl. xviii., fig. 6; pl. xix., figs. 1, 2; upper Silurian. Of the syntypes listed by Dun the following are in the Australian Museum—Section A.M. 261 (19), no specimen; F 5174, with two sections A.M. 57 from Yass; F. 4081 (not 4801) with two sections A.M. 60 from Humewood; and F 4498, with two sections A.M. 55 from Yarralumla. The rest are lost. We select as lectotype the specimen F 5174 with two sections A.M. 57 from Yass, N.S.W.

? *Heliolites wellingtonensis* (nom. nud.) Dun, 1927, p. 256.

Heliolites barrandei Penecke; Kettnerova, 1932, p. 2, figs. 1, 2; Devonian of Graz.

? *Heliolites vesiculosus* Penecke; Kettnerova, 1932, p. 7, figs. 3, 4; Osternig, north of Tarvis in the Carnic Alps, probably M. Devonian.

Heliolites praeporosus Kettnerova, 1933a, p. 1, figs. 1, 2; Koneprus, L. Devonian.

? *Helioplasma kolihai* Kettnerova, 1933b, p. 182, figs. 1, 2; Koneprus, L. Devonian.

Lectotype (here chosen).—The specimen 90248, British Museum (Natural History), figured Nicholson and Etheridge, 1879, pl. xiv., figs. 3, 3a. Devonian. Broken River, North Queensland. Pl. VII., fig. 2.

Diagnosis.—*Heliolites* with tabularia of variable size with twelve short lamellar septa having numerous long upcurved spines vertical near the axis and swollen at the apices in late forms; with distant regularly horizontal tabulae; with tubuli regularly polyhedric or vermiform, sometimes rounded in late forms; and with the walls of the tabularia and tubuli rather thickened in late forms.

Description.—Lindström (1899, pp. 58-60) has given an adequate description of the species based on European and American material. We supplement it with a description of the Australian specimens, which can be treated in four ill-defined groups.

First group (Plate VI., figs. 1-4).—The external form is unknown but the coralla probably are hemispherical or slightly domed. The tabularia have a diameter of 1 to 2 mm. and their distance apart is from 0·25 to 2·25 mm., with one to six rows of tubuli between. The walls of the tabularia are thin or slightly thickened and sometimes crenulate. The septa arise from the crenulations when these are present, and are short lamellae breaking up axially into long, sharply upcurved spines. The tabulae are thin, rather distant and usually horizontal. The reticulum consists of tubuli of variable transverse section; they may be polyhedric or have rounded angles and may be equal or unequal in size; their walls are equal in thickness to those of the tabularia. The sola are thin and rather closer than the tabulae.

Second group (Plate VI., fig. 5).—This is similar in all particulars to the first group except that the coralla are small and globular, and that one to three rows of tubuli separate the tabularia.

Third group (Plate VII., fig. 1).—This is similar to the first group except that the tabularia are 1 to 1·5 mm. in diameter, with one to four rows of tubuli between; the septal spines are well developed and have swollen apices; the walls of the tabularia are thickened and crenulate, the septa arising from the crenulations; and the tubuli are small, regular, and rather rounded.

Fourth group (Plate VII., figs. 2-5, plate VIII., plate IX., fig. 1).—The corallum is massive and hemispherical, and may be large (Dun records one corallum measuring 20 cm. in diameter and 12 to 15 cms. in height). The tabularia range in diameter from 0·5 mm. to 2 mm. and vary greatly in distance apart in different specimens. The distance between the tabularia varies between 0·25 mm. and 6 mm. and is in general least in those coralla with the largest tabularia. The walls of the tabularia are thin, but are usually a little thicker than those of the tubuli; they are not quite circular, having slight angles where two tubuli meet; the septa usually arise from the walls between these angles, occasionally from the angles themselves; rarely crenulations between the angles form the bases of the septa. The septa are lamellar peripherally but axially they consist of long upcurved spines, which are frequently obscured by recrystallisation. The tabulae are as in the other groups. The tubuli are small, polyhedric, rounded or sometimes vermiform in transverse section. In longitudinal section their walls are usually straight but they may be slightly constricted at the sola. The sola are complete, more numerous than the tabulae, usually horizontal, but sometimes curved, inclined or geniculate.

Remarks.—Lindström places in this species forms from the Upper Llandovery, Wenlock, Ludlow and Lower Devonian of Europe, and the Niagaran of America. He considered that, in spite of variation in size and distance apart of the tabularia and of the thickness of the walls, the group forms a single species by reason of the constant and characteristic nature of the septa. These are lamellar in the peripheral part of the tabularia, but in the axial region they are spines, curving to the vertical. This gives a characteristic transverse section showing linear septa at the edge of the tabularia and dot-like sections of spines at the axis.

Lindström considered that the later forms were distinguishable from the earlier by the swollen axial ends of the septal spines and that some, but not all, Devonian specimens showed thickened tubuli walls with rounded angles. This is in agreement with our observations on the Australian specimens. We agree with Lindström that all these forms are better regarded as a species rather than as a genus; we do not consider the character of the septa, which is the most characteristic feature of the group, to be of generic importance.

As will be seen from the description above, it is possible to divide the Australian forms at least, into ill-defined groups on the characters of the septa; if, however, the reticulum which is the most variable element be considered as a character of classificatory value, a useless multiplicity of forms could be named. We have not given names to the Australian groups, as we have no evidence as yet that the differences are either specific or stratigraphical in value; they are small and gradations occur.

Kettnerova has given descriptions of Bohemian Lower Devonian *Heliolites*; we have not seen specimens, but from her descriptions and figures, we consider *H. praeporosus* is *H. daintreei* and that *H. vesiculosus* and *Helioplasma kolahai* may also be synonyms of *H. daintreei.*

Of our Australian material we place in the first group single specimens from Clermont, Chillagoe, Mount Etna, and Jenolan. While the septal characters in this group are constant, the reticulum varies in different parts of the one specimen and from specimen to specimen. The tubuli are the most unequal and irregular in the Clermont specimen and are most nearly equal and regular in those from Mount Etna and Jenolan. This group appears to be the most similar to the Austrian forms described by Penecke and Kettnerova.

The second group is confined to the Cave Limestone at Wellington, New South Wales.

The third group is known only from Lilydale, Victoria, and the specimens show little variation.

In the fourth group we place specimens from Yass, Molong, and the Broken River. In the Yass specimens the variation in size of the tabularia and their distance apart is extreme and from our limited material it might be possible to distinguish two sub-groups, one in which the tabularia are 1·5 to 1·75 mm. in diameter and as little as 0·25 mm. apart; the other in which the tabularia are 0·5 to 1 mm. in diameter and as much as 6 mm. apart. There is, however, only a general and not a definite relationship between the size of the tabularia and their distance apart. Thus in two specimens with tabularia of approximately the same size (0·75 mm.) the distance between the tabularia is about 2·5 mm. and 1 mm. respectively. The most typical feature of the group is the shape in transverse section of the tabularia, which is somewhat similar to Lindström's Silurian *H. barrandei* var. *spongodes*. This has the least crenulation of the forms he examined, but it differs greatly in external form from the Yass specimens, and has slight crenulations where the septa join the walls. We place in this group *H. yassensis* Dun, *H. regularis* Dun var. *humewoodensis,* and *H. jackii* Dun. We have examined those of Dun's thin sections that have not been lost, and consider that he did not allow for the wide variation occurring within the various species of *Heliolites*. We have observed characters, which he considered diagnostic of different species, in the one specimen. Further, he appears to have failed to realise to what a great extent the septa of the Yass specimens are obscured by the recrystallisation of the matrix. In spite of this recrystallisation we have observed, under suitable illumination, septa of the characteristic *daintreei* type in nearly all his sections. The Molong material is even more crystalline and septa are observable in sections of one specimen only. The septa in this are quite characteristic and other characters leave no doubt that all four specimens belong to the same species. We place the lectotype of *H. daintreei* in this fourth group, although the diameter of its tabularia, 2 mm., is larger than in any specimen from other localities. *H. plasmoporoides* is *H. daintreei,* but we place it in the fourth group rather doubtfully as we have seen only one specimen and its preservation is poor. It has tabularia of 2 mm. diameter and the reticulum is mostly vermiform though regular in places.

Australian Localities.—1st Group: Portion 73, parish Copperfield, Clermont, Queensland, Lower Middle Devonian; Foot of Mount Etna,

Rockhampton, Queensland, ?Lower Middle Devonian; Chillagoe, Queensland (Geol. Surv, No. F 1964), Silurian; Mount St. George, Jenolan, New South Wales (Australian Museum, F 4108, with two sections A.M. 61), Silurian. 2nd Group: Wellington Caves, New South Wales (Australian Museum, sections A.M. 259), ?Siluro-Devonian. 3rd Group: Lilydale, Victoria, Lower or Middle Devonian. 4th Group: Hatton's Corner, Yass, and Old Limekilns Ridge, Humewood, Yass, New South Wales, Upper Silurian; portion 3, parish Cudal, just west of Boree Creek on back road from Manildra to Cudal, near Molong, New South Wales, Lower Devonian (University of Queensland Collection, F 3408, with two sections); portion 170, parish Curra, near Wellington, New South Wales, Curra Creek, Crossing No. 2, east of road crossing, Lower Devonian (U.Q., F. 3409, with two sections); portion 174, parish Bell, county Ashburnham, Crystal Springs, near Molong, New South Wales, Lower Devonian (U.Q., F. 3410, with two sections); Mandagery's Creek, parish Brymedura, north of Garra, near Molong, New South Wales (probably portion 77), Lower Devonian (U.Q., F. 3411, with two sections on one slide); Broken River, tributary of Clarke River, North Queensland, Devonian (British Museum, Natural History specimens 90246 and 90248, with two slides of each).

Range.—Lindström described the species from Gotland in strata from a-f (Upper Llandovery to Ludlow), from the Lower Devonian (*barrandei* beds) of Austria and from the Niagaran of America. Kettnerova (1932, 1933) figured it from the Lower Devonian of Bohemia, and Le Maître (1934, pl. vii., figs. 5-8) recorded it from Ancenis in beds transitional from the Lower Devonian to the Middle Devonian. In Australia the first group is Lower Middle Devonian at Clermont, and possibly at Mount Etna also, Silurian at Chillagoe and at Jenolan. The second group is Siluro-Devonian. The third group is Devonian. The fourth group is Upper Silurian at Yass, Lower Devonian at Molong, and Devonian at Broken River.

Heliolites nicholsoni Eth. fil.

Heliolites sp. ind. Nicholson and Etheridge, 1879, p. 223.

Heliolites nicholsoni Etheridge, in Jack and Etheridge, 1892, p. 63, pl. 1, fig. 12.

We have been unable to trace this. Etheridge states it is in the British Museum, but Dr. H. D. Thomas in a letter says: "We have not got, nor is there any record that we ever had, the other specimen (i.e. *H. nicholsoni*). It is said to be in a large corallum of *Favosites* but I have examined all ours from Broken River, Queensland, and none contains a Heliolitid."

Judging from the figure in Jack and Etheridge it is quite possible that this species is *Plasmopora heliolitoides* Lindström.

Locality.—Broken River, tributary of the Clarke River, North Queensland. Devonian.

Heliolites interstinctus (Linnaeus). (Plate IX., fig. 2.)

Madrepora interstincta Linnaeus, 1767, p. 1276.

Heliolites interstinctus; Lindström, 1899, p. 41, pl. i., figs. 1-36; pl. ii., figs. 1, 2; pl. iii., figs. 1, 2.

Lectotype.—The specimen from Gotland described and figured by Linnaeus, 1745, p. 30, fig. xxiv. (chosen by Lindström, 1899, p. 42).

Diagnosis.—*Heliolites* with thin walled tabularia of variable size; usually with non spinose septa which arise from the crenulations; typically with a discontinuous columella; the tubuli are polygonal. In some coralla some or all of the tubularia are without crenulations, septa, or columella (*decipiens* variation).

Remarks.—A very crystalline specimen (University of Queensland, F 3437, with two slides) from the ?Silurian of Limestone Bluff, Mungana. North Queensland, may possibly belong to this species. It is probably of the *decipiens* morphology but this appearance may be due to its re-crystallisation.

Range.—Lyckhohm beds of the Baltic, Gotlandian of Scandinavia, Wenlock and Ludlow of England and Bohemia, Silurian of Arctic Russia and Australia, and Niagaran of America; Lindström also records it as passing up into the Middle Devonian of the Carnic Alps.

Heliolites porosus (Goldfuss). (Plate IX., fig. 3.)

Astraea porosa Goldfuss, 1826, p. 64, pl. xxi., fig. 7; Devonian of the Eifel.

Heliolites porosus; Lindström, 1899, p. 53, pl. ii., figs. 29-37; pl. iii., fig. 3-7.

Heliolites porosa; Etheridge, 1899b, pp. 173-4, pl. xix., figs. 3, 4; pl. xxv., figs. 1, 2; Middle Devonian of Tamworth, N.S.W.

Heliolites porosus; Lecompte, 1936, p. 93, pl. xiv., figs. 2-5.

Type Material.—Goldfuss' syntypes from the Devonian of the Eifel and Heisterstein are in the University of Bonn. They were refigured and fully described by Lecompte *loc. cit.*

Diagnosis.—*Heliolites* with tabularia thick walled and crenulate, with unequal septa arising from the crenulations; the septal lamella have the axial edges obtusely denticulated or fringed with curved spines; the tubuli are small with thick walls.

Remarks.—All the vertical walls are thick but those of the tabularia are markedly more so than those of the tubuli. The septa are thick, straight lamellae, with short spines on the axial edge; the spines are not curved and are only slightly directed upwards so that in transverse section they form neither a network as in *parvistella* nor numerous dots as in *daintreei*. The septa are always unequal and are sometimes alternate in length.

Localities and Range.—In the Middle Devonian of New South Wales, at Moore Creek and Woolomol, near Tamworth, and on the Isis River, near Crawney; in the Givetian Burdekin Downs Limestone of North Queensland, at numerous localities on the Burdekin Downs and Fanning River Stations, and in the Reid Gap, near Townsville; in the Lower Middle Devonian Limestone at Elbow Valley, Silverwood, Queensland; and in the Middle Devonian Limestone in Kroombit Creek, 5 miles above Kroombit Station, near Biloela, Queensland.

Genus *Plasmopora* Edwards and Haime.

Plasmopora Edwards and Haime, 1849, p. 262.

Plasmopora; Lindström, 1899, p. 75.

Genotype (by monotypy).—*Porites petalliformis* Lonsdale, 1839, p. 687, pl. xvi., figs. 4, 4a. From the Wenlock shale. Walsall.

Diagnosis.—Heliolitida with each tabularium surrounded by an aureola of twelve tubuli, whose dividing walls typically continue into the

tabularia as septa; additional tubuli whose walls may be discontinuous occur between the aureolae; testae may occur when the walls are discontinuous, otherwise sola are developed. Carinae may occur.

Range.—The range in Europe and America is Llandovery of Gotland, G1 of Estland; Wenlock of England, Gotland and Estland; Ludlow of Gotland; the Niagaran of America; and Middle Devonian of the Carnic Alps (Vinassa de Regny, 1918, p. 89). In Australia it occurs in the Upper Silurian of Yass, Lower Devonian of Molong, New South Wales, Silurian [?Lower Devonian] of Coopers Creek, Victoria, and Devonian of Johannsen's Caves, Rockhampton, Queensland, and of the Nundle road, Tamworth, New South Wales.

Table II. summarises the characters and range of the species recognised by Lindström. A full account of the micro-structure of the septa and walls has already been given, p. 187.

Plasmopora heliolitoides Lindström. (Plate IX., figs. 4, 5; pl. X., figs. 1-4.)

Plasmopora heliolitoides Lindström, 1899, p. 86, pl. vii., figs. 32-33.

Heliolites distans Dun, 1927, p. 258, pl. xix., figs. 3-6. Syntypes in the Australian Museum are F. 5173 (misprinted 5178 in explanation to plate) with two sections A.M. 56, from Yass, and F. 4082 with two sections A.M. 140, from Old Limekilns Ridge; upper Silurian. Lectotype (here chosen) F. 5173, A.M. 56, figured Dun, *loc. cit.*, figs. 5, 6.

Heliolites distans var. *humewoodensis* Dun, 1927, p. 261, pl. xx., figs. 3, 4. Syntypes in the Australian Museum are F. 4082, with two sections A.M. 43; F. 5547, with two sections A.M. 71; F. 5548, with two sections A.M. 72, all from the Old Limekilns Ridge, Humewood; upper Silurian. Lectotype (here chosen) F. 4082, A.M. 43, Dun, *loc. cit.*, figs. 3, 4.

Heliolites distans var. *intermedia* Dun, 1927, p. 261, pl. xx., figs. 5, 6. Syntypes in the Australian Museum are F. 5555, with two sections A.M. 75; F. 5556, with two sections A.M. 76; and F. 2433, with two sections A.M. 52; all from Old Limekilns Ridge, Humewood. Upper Silurian. Lectotype (here chosen F. 5556, A.M. 76, figured Dun, *loc. cit.*, figs. 5, 6.

Heliolites distans var. *minuta* Dun, 1927, p. 262, pl. xxi., figs. 1-4. Syntypes in the Australian Museum are A.M. 237 (specimen apparently lost) from the Yass District, F. 5553, with two sections A.M. 73, F. 5554, with two sections A.M. 74, both from Old Limekilns Ridge, Humewood, and F. 2461, with two sections A.M. 53, from Bowning. Upper Silurian. Lectotype (here chosen) F. 5553, A.M. 73, figured Dun, *loc. cit.*, figs. 1, 2, 4.

Type Material.—In the Lindström collection in Stockholm; from Stratum d (Wenlock) of Ostergarn, Gotland.

Diagnosis.—*Plasmopora* with the tubuli of the aureola irregular and unequal in size frequently elongated parallel to the circumference of the tabularia, with septa absent or represented by blunt protuberances and with the walls in the reticulum continuous.

Description.—The corallum is large and spreading and the tabularia vary greatly in size and distance apart. Their diameter varies from 1·75 mm. to 1 mm. and their distance apart from 1·5 to 5 mm. The walls of the tabularia are slightly thicker than those of the tubuli. The septa are rudimentary, represented by knob-like swellings which are continuations of the radial walls of the aureola. They are not lamellar but are blunt rounded spines. The tabulae are complete, usually horizontal, 12 to 16 in a space of 5 mm. The twelve tubuli forming the aureola are frequently smaller than, occasionally equal to, or a little larger than the other tubuli. They often have their long axes parallel to the circumference of the tabularia and are unequal. The remainder of the reticulum consists of tubuli almost equal in diameter but of variable shape. The tubuli are not always parallel to

the tabularia, frequently changing their direction of growth slightly. Some are polyhedric, others have rounded corners, and a few are alveolitoid frequently with a carina projecting from one side. The sola are horizontal, oblique or inosculating, about 24 in a space of 5 mm.

Remarks.—In this species the tubuli of the aureola are frequently elongated parallel to the circumferences of the tabularia whereas in all other species they are elongated in a radial direction. This, combined with the form of the septa (knob-like spines), gives the species its characteristic appearance. Carinae when present occur only in the reticulum and each probably represents the beginning of a new tubuli wall.

Range.—Stratum d (Wenlock) of Ostergarn, Gotland; Upper Silurian of Hatton's Corner and Derrengullen Creek, Yass, and of Old Limekilns Ridge, Humewood.

Plasmopora gippslandica (Chapman). (Plate X., fig. 5, pl. XI., fig. 1.)

Heliolites interstincta var. *gippslandica* Chapman, 1914, p. 311, pl. ix., figs. 35, 36. Silurian [? Devonian]. Cooper's Creek, Thomson River, Victoria.

non *Heliolites interstincta* var. *gippslandica* Chapman, 1920, see p. 200.

Heliolites regularis Dun, 1927, p. 256, pl. xviii., figs. 2, 3. Upper Silurian. Hatton's Corner, Yass, N.S.W.

Holotype.—The specimen described and figured by Chapman, loc. cit., thought to be in the National Museum, Melbourne, M.D. 746, Slide 1336.

Diagnosis.—*Plasmopora* with the tubuli of the aureola usually elongated radially, and neighbouring aureolae in contact or occasionally separated by one or two rows of tubuli; with tubuli walls continuous vertically, and septa absent.

Description.—The external form is unknown. The tabularia show in cross sections as smooth and round with no sign of septa. Their diameter ranges from 1 to 1·5 mm. and they are from 0·5 to 1·5 mm. apart. The walls of the tabularia are but little if any thicker than the walls of the tubuli. The tabulae are mostly complete and horizontal but a few may be inosculating; 10 occupy a space of 5 mm. The tubuli of the aureola are radially elongated when the tabularia are sufficiently distant, and are usually equal in size; they are polyhedric except in parts of some coralla where the walls are somewhat thickened when the angles are rounded. When tubuli occur between the aureolae they are smaller than those of the aureola; not more than two such rows are developed. The sola are mostly complete, a few are inosculating or geniculate, and there are 10 to 14 in a space of 5 mm. The tubuli walls are frequently constricted at their junctions with the sola.

Remarks.—The absence of septa, the continuity of the walls, and the shape of tubuli of the aureola (radially elongated) distinguish this species. Of the European Silurian species it is closest to *P. heliolitoides* (Wenlock of Gotland) and *P. rudis* (uppermost Ludlow of Gotland). It differs from both in the absence of septa, from *heliolitoides* in the shape of the tubuli of the aureola and from *rudis* in having the tubuli walls vertically continuous. It appears to be very similar to the Middle Devonian *P. carnica* Vinassa de Regny (1918, p. 89, pl. vii., figs. 4, 5) but the sections of the latter are oblique so that we cannot be sure of complete identity.

TABLE II.

SUMMARY OF CHARACTERS AND RANGE OF SPECIES OF *Plasmopora* RECOGNISED BY LINDSTROM.

Species.	Nature of Septa.	Nature of Tubuli Walls.	Size of Aureolar tubuli relative to size of other tubuli.	Horizontal Elements of Reticulum.	Range.
petalliformis	acanthine	discontinuous	larger	testæ	Wenlock of England and Wenlock and Ludlow of Gotland
forœnsis	acanthine	mostly continuous	larger	testæ	Ludlow of Gotland
calyculata	lamellar with spines ..	discontinuous	larger	testæ	Wenlock of Gotland and England
scita	rhabdacanthine	discontinuous (monacanths in vertical series)	larger	testæ	Wenlock of England and Gotland; Niagaran of America
follis	acanthine	continuous and wavy ..	larger	sola	Niagaran of America
stella	lamellar with spines ..	mostly continuous	larger	sola	Llandovery of Gotland
scala	lamellar with spines ..	mostly continuous	larger	mostly sola	Llandovery of Gotland
rosa	lamellar with short spines..	mostly continuous and wavy	larger	some testæ, inosculating sola	Ludlow of Gotland
suprema	short, lamellar with spines..	mostly continuous and wavy	larger	sola and testæ	Ludlow of Gotland
rudis	slight swellings on the wall	mostly continous	about equal	some testæ, inosculating sola	Ludlow of Gotland
heliolitoides	slight swellings on the wall	continuous	variable, unequal, usually smaller	sola	Wenlock of Gotland
? *reticulata*	absent	discontinuous (monacanths in vertical rows)	about equal	testæ	Llandovery of Gotland

Localities and Age.—Johannsen's Caves, Rockhampton, Devonian (F 5512, Australian Museum); Nundle road, near Tamworth, New South Wales, Devonian (F. 6936, Australian Museum); portions 31 and 174, parish Bell, county Ashburnham, near Molong, New South Wales, and portion 170, parish Curra, near Wellington, New South Wales, Lower Devonian; Hatton's Corner, Yass, New South Wales, Upper Silurian; Cooper's Creek, Thomson River, Victoria, Silurian [?Devonian].

We have been unable to trace the specimen figured by Dun (*loc. cit.*), said by him to be in the Mining Museum, Sydney, and his description is obscure and his measurements contradictory; he does not give the magnification of the figures. In large collections from Hatton's Corner, Yass, we have found no similar specimens. Nevertheless we have no doubt that it should be referred to this species.

The specimen figured by Chapman, *loc. cit.*, could not be *Heliolites interstincta* since it possesses the diagnostic character of *Plasmopora*, viz., an aureola of 12 tubuli.

Plasmopora sp. cf. *gippslandica* (Chapman).

(Plate XI., fig. 2.)

One poorly-preserved specimen from Boomerang Tank, Canbelago, near Cobar, New South Wales, in the Australian Museum, probably Silurian is similar to *gippslandica* but the walls of both the tabularia and tubuli are considerably thickened and the angles of the tubuli are rounded. Occasionally there is only one row of tubuli between adjoining tabularia. The tubuli are unequal in size.

Genus *Propora* Edwards and Haime.

Propora Edwards and Haime, 1849, p. 262.

Lyellia Edwards and Haime, 1851, p. 226.

Pinacopora Nicholson and Etheridge, 1878. Genotype *P. grayi* Nicholson and Etheridge, *loc. cit.*, p. 54, pl. iii., figs. 3-3j. Silurian. Girvan.

Propora; Lindström, 1899.

Genotype.—*Porites tubulata* Lonsdale, 1839, p. 687, pl. 16. figs. 3, 3a, 3b (non figs. 3c-f. See Edwards and Haime, 1850, p. lix.). Wenlock Limestone.

Diagnosis.—Heliolitida in which the reticulum consists of testae; with spinose septa; and with a variable development of discrete trabeculae throughout the tissue.

Range.—Upper Ordovician of North America, England, Scandinavia, and the Baltic States; Silurian (Valentian to Ludlovian) of Europe; Niagaran of America; Gotlandian of Korea; and Upper Silurian of Australia.

Remarks.—*Lyellia* was founded on two genosyntypes—*L. americana* Edwards and Haime (1851, p. 226, pl. 14, figs. 3, 3a) from Drummond Island, on Lake Huron, North America, Silurian, and *Sarcinula glabra* Dale Owen (1844, p. 76, pl. 11, fig. 11, see Edwards and Haime, 1851, p. 226, pl. 12, figs. 2, 2a-c) Upper Silurian, Iowa. Lindström (1899, pp. 92, 100) has shown that both these species rightly belong in *Propora* and therefore *Lyellia* is a synonym of *Propora*.

Pinacopora was founded for a number of small, concavo-convex, leaf-life expansions. We have not seen specimens but from the description and figures we agree with Lindström (1899, p. 99) that it is probably identical with *Propora*.

The morphology of the genus has been fully discussed above, see p. 187.

Propora conferta Edwards and Haime. (Plate XI., figs. 3-5.)

Propora conferta Edwards and Haime, 1851, p. 225. Borkholm (? F2), Chavli Canal de Windau, Russia.

Plasmopora australis Etheridge, 1899a, p. 33, pl. A, fig. 11; pl. B, figs. 5, 6. Silurian. Wombat Creek, Victoria. Figured specimen missing.

Propora conferta; Lindström, 1899, p. 93, pl. viii., figs. 32-39; pl. ix., figs. 1-23, 31, 32, 35.

Plasmopora shearsbyi Dun, 1927, p. 262, pl. xxi., figs. 5, 6. Lectotype, here chosen, the sections A.M. 256 (E. 21) in the Australian Museum, from Yass; upper Silurian. Other syntypes including the one figured are lost.

Syntypes.—Two specimens in the de Verneuil collection, Ecole de Mines, Paris, described by Lindström *loc. cit.*, p. 93.

Diagnosis.—*Propora* in whose tabularia the septa are extremely short or absent; with a reticulum of testae on which very short, thin separate trabeculae may occur; the walls of the tabularia may be crenulate, the outer angles being produced into the reticulum as short ridges.

Remarks.—The variation in the diameter of the tabularia and in their distance apart is very great in this species. In the Yass specimens the tabularia vary from just under 1 mm. in diameter to over 2 mm., and their distance apart varies from 0·25 mm. to 2·5 mm. In transverse section short breaks in the walls of the tabularia are sometimes seen. Of the individuals of this species figured by Lindström, his pl. ix., figs. 5 6, from the Upper Silurian (Ludlovian) of Tsien-shui River, China, is closest to the Yass form. This shows the same keeled crenulations and discontinuity of the tabularial walls. Etheridge's specimen from Victoria, which we have been unable to trace, is from the figures, obviously to be referred to this species.

Range.—*Propora conferta* has a long range—from the Upper Ordovician (?Trenton) of Iglulik Island (*Plasmopora lambei*) and stage 5a of Norway, through the Llandovery to the Wenlock of England, Estland and Gotland, the Niagaran of America, and the Upper Silurian of Tsien-shui of China, of Yass, New South Wales, and the Silurian of Eastern Victoria.

Upper Silurian Localities in Australia.—Yass, New South Wales (Australian Museum, A.M. 256); Derrengullen Creek, Yass (University of Queensland, F 3300); portion 161, parish Yass (Australian Museum, F 8233, A.M. 553); Old Limekilns Ridge, Humewood, near Yass (Australian Museum, F4083, A.M. 64 and A.M. 54); Wombat Creek, Victoria. Dun also records *P. shearsbyi* from Hatton's Corner, Yass, and from Bungonia, east of Goulburn, New South Wales, but we have been unable to trace the specimens.

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EXPLANATION OF PLATES.

PLATE VI.

Heliolites daintreei Nicholson and Etheridge.

All figures approximately × 3 diameters.

First group.

Fig. 1.—F 3461, University of Queensland. Douglas Creek, Clermont, Queensland. Lower Middle Devonian. 1a, transverse section; 1b, vertical section.

Fig. 2.—F 3462, University of Queensland. Por. 120, par. Fitzroy (foot of Mount Etna), near Rockhampton, Queensland. ?Lower Middle Devonian. 2a, transverse section; 2b, vertical section.

Fig. 3.—F 1964, Geological Survey of Queensland. Chillagoe, North Queensland. Silurian. Transverse section.

Fig. 4.—AM 61, F 4108, Australian Museum. Mount St. George, Jenolan, N.S.W. ?Silurian. 4a, b, transverse section; 4c, vertical section.

Second group.

Fig. 5.—AM 259, 2608, Australian Museum. Wellington Caves, N.S.W. ?Lower Devonian. 5a, vertical section; 5b, transverse section.

PLATE VII.

Heliolites daintreei Nicholson and Etheridge.

All figures approximately × 3 diameters.

Third group.

Fig. 1.—L. 4, Melbourne University. Lilydale, Victoria. Lower Devonian. 1a, transverse section; 1b, vertical section.

Fourth group.

Fig. 2.—90248, British Museum, London. Holotype. Broken River, North Queensland. Devonian. 2a, transverse section; 2b, vertical section.

Fig. 3.—90246, British Museum, London. Lectotype of *Heliolites plasmoporoides* Nicholson and Etheridge. Broken River, North Queensland. Devonian. Transverse section.

Fig. 4.—AM 62, from F 5176, Australian Museum. Lectotype of *Heliolites yassensis* Dun. Hattons Corner, Yass, N.S.W. Upper Silurian. 4a, transverse section; 4b, vertical section.

Fig. 5.—AM 57, from F 5174, Australian Museum. Lectotype of *Heliolites jackii* Dun. Yass, N.S.W. Upper Silurian. 5a, transverse section; 5b, vertical section.

Plate VIII.

Heliolites daintreei Nicholson and Etheridge.

Fourth group.

All figures approximately × 3 diameters.

Fig. 1.—AM 261 (19), Australian Museum. Syntype of *Heliolites jackii* Dun. 1a, transverse section; 1b, vertical section.

Fig. 2.—F 3294, University of Queensland. Hatton's Corner, Yass, N.S.W. 2a, transverse section; 2b, vertical section.

Fig. 3.—F 1024, University of Queensland. Hatton's Corner, Yass. N.S.W. 3a, transverse section; 3b, vertical section.

Fig. 4.—Tranverse section, Hatton's Corner, Yass, N.S.W.

Fig. 5.—F 3410, University of Queensland. Por. 174, par. Bell, co. Ashburnham (Crystal Springs), near Molong, N.S.W. Lower Devonian. Transverse section.

Fig. 6.—F 3411, University of Queensland. Mandagery's Creek, par. Brymedura, north of Garra, near Molong, N.S.W. Lower Devonian. Vertical section.

Fig. 7.—F 3408, University of Queensland. Por. 3, par. Cudal, just west of Boree Creek, on road from Manildra to Cudal, near Molong, N.S.W. Lower Devonian. Transverse section.

Fig. 8.—F 3463, University of Queensland. Spring Creek, near Mount Canoblas, N.S.W. Upper Silurian. Transverse section.

Plate IX.

All figures approximately × 3 diameters.

Heliolites daintreei Nicholson and Etheridge, fourth group.

Fig. 1. F 3464, University of Queensland. Spring Creek, near Mount Canoblas, N.S.W. Upper Silurian. Transverse section.

Heliolites ?interstinctus (Linnaeus).

Fig. 2.—F 3437, University of Queensland. Limestone Bluff, Mungana, North Queensland. Silurian. 2a, transverse section; 2b, vertical section.

Heliolites porosus (Goldfuss).

Fig. 3.—Geological Survey of Queensland. Five miles above Kroombit Station, Kroombit Creek, near Biloela, Queensland. Middle Devonian. 3a, transverse section; 3b, vertical section.

Plasmopora heliolitoides Lindström.

Fig. 4.—AM 43, from F 4082, Australian Museum. Lectotype of *Heliolites distans* var. *humewoodensis* Dun. Old Limekilns Ridge, near Yass, N.S.W. Upper Silurian. 4a, transverse section; 4b, vertical section.

Fig. 5.—AM 56, from F 5173, Australian Museum. Lectotypes of *Heliolites distans* Dun. Yass. Upper Silurian. 5a, b, transverse sections.

Plate X.

All figures approximately × 3 diameters.

Plasmopora heliolitoides Lindström.

Fig. 1.—AM 56, from F 5173, Australian Museum. Lectotype of *Heliolites distans* Dun. Yass. Upper Silurian. 1a, transverse section; 1b, vertical section.

Fig. 2.—AM 76, from F5556, Australian Museum. Lectotype of *Heliolites distans* var. *intermedia* Dun. Old Limekilns Ridge, Humewood, near Yass, N.S.W. Upper Silurian. Transverse section.

Fig. 3.—AM 73, from F 5553, Australian Museum. Lectotype of *Heliolites distans* var. *minuta* Dun. Old Limekilns Ridge, Humewood, near Yass, N.S.W. Upper Silurian. 3a, transverse section; 3b, c, vertical sections.

Fig. 4.—F 3296, University of Queensland. Hatton's Corner, Yass, N.S.W. Upper Silurian. 4a, transverse section; 4b, c, vertical sections.

Plasmopora gippslandica (Chapman).

Fig. 5.—AM 271, from F 6936, Australian Museum. Nundle road, near Tamworth, N.S.W. Devonian. Transverse section.

PLATE XI.

All figures approximately × 3 diameters.

Plasmopora gippslandica (Chapman).

Fig. 1.—AM 66, from F 5512, Australian Museum. Johannsen's Caves, near Rockhampton, Queensland. ?Lower Middle Devonian. 1a, transverse section; 1b, vertical section.

Plasmopora cf. *gippslandica* (Chapman).

Fig. 2.—Australian Museum. Limestone beds at Boomerang Tank, Canbelago, near Cobar, N.S.W. ?Silurian. Transverse section.

Propora conferta Edwards and Haime.

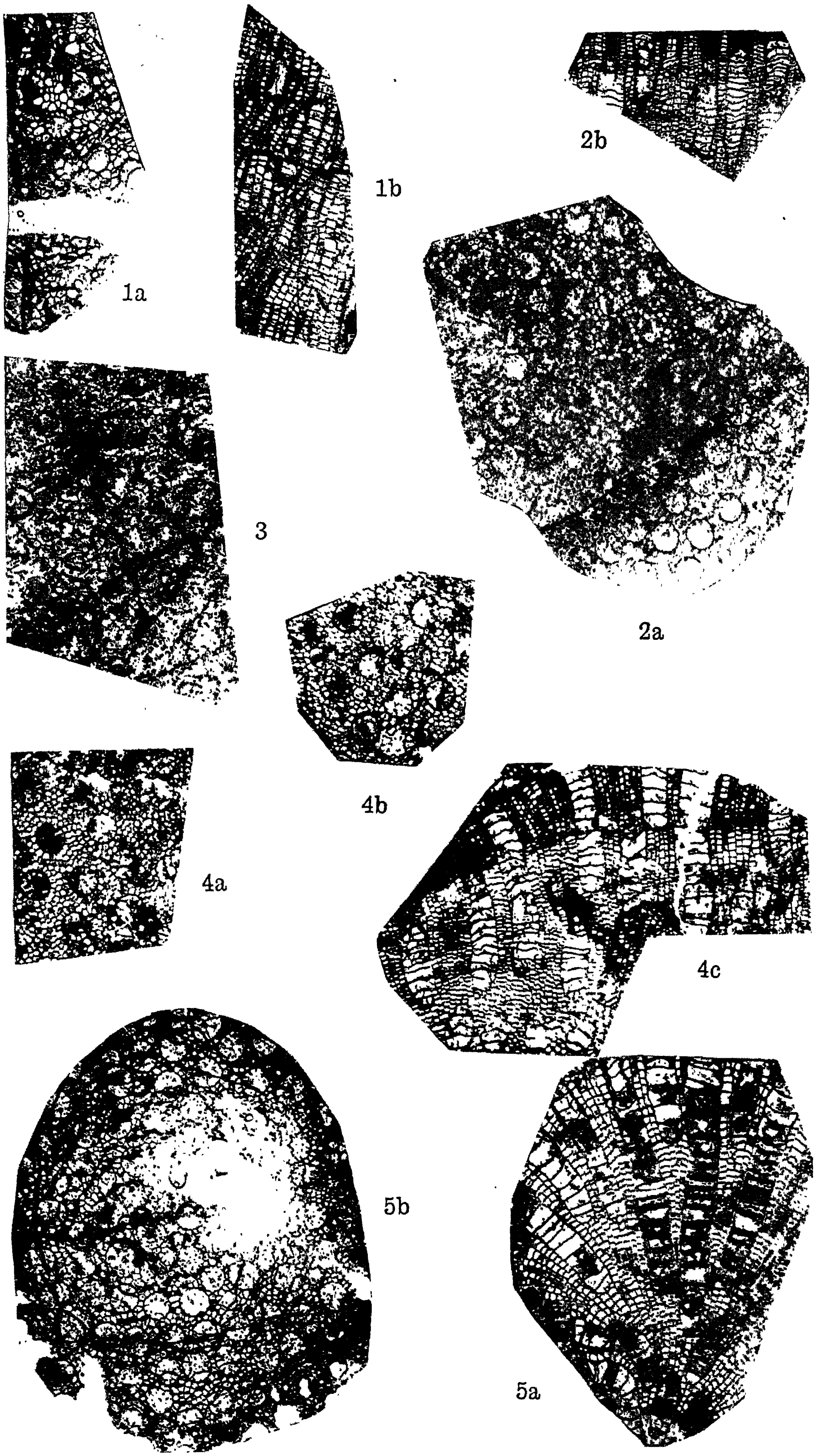
Fig. 3.—F 3300, University of Queensland. Hatton's Corner, near Yass, N.S.W. Upper Silurian. Transverse section.

Fig. 4.—F 3465, University of Queensland. Bowspring Limestone, Hatton's Corner, N.S.W. Upper Silurian. Transverse section.

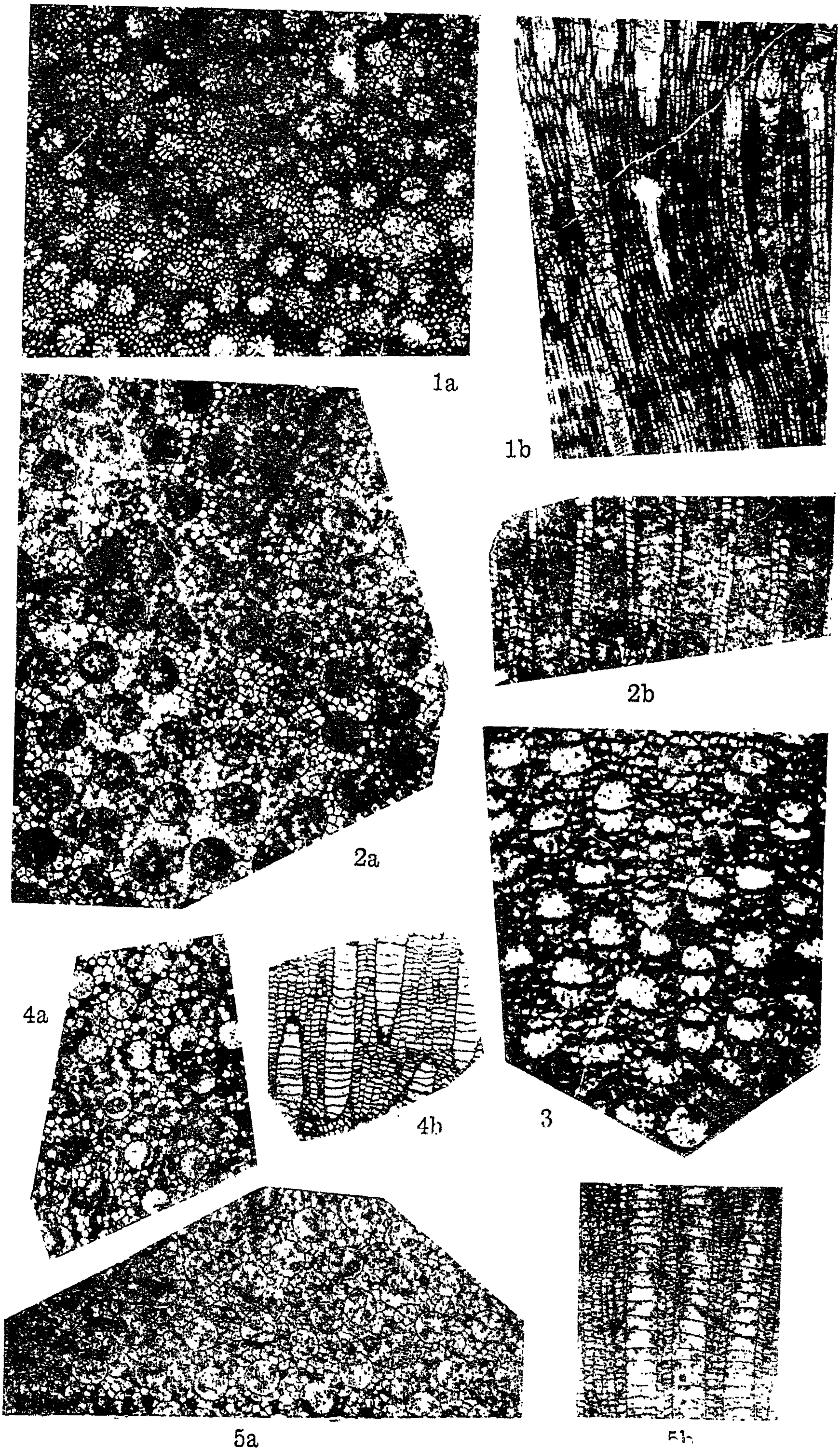
Fig. 5.—AM 256 (21), Australian Museum. Yass, N.S.W. Upper Silurian. 5a, transverse section; 5b, vertical section.

Heliopora coerulea (Pallas, Ellis and Solander).

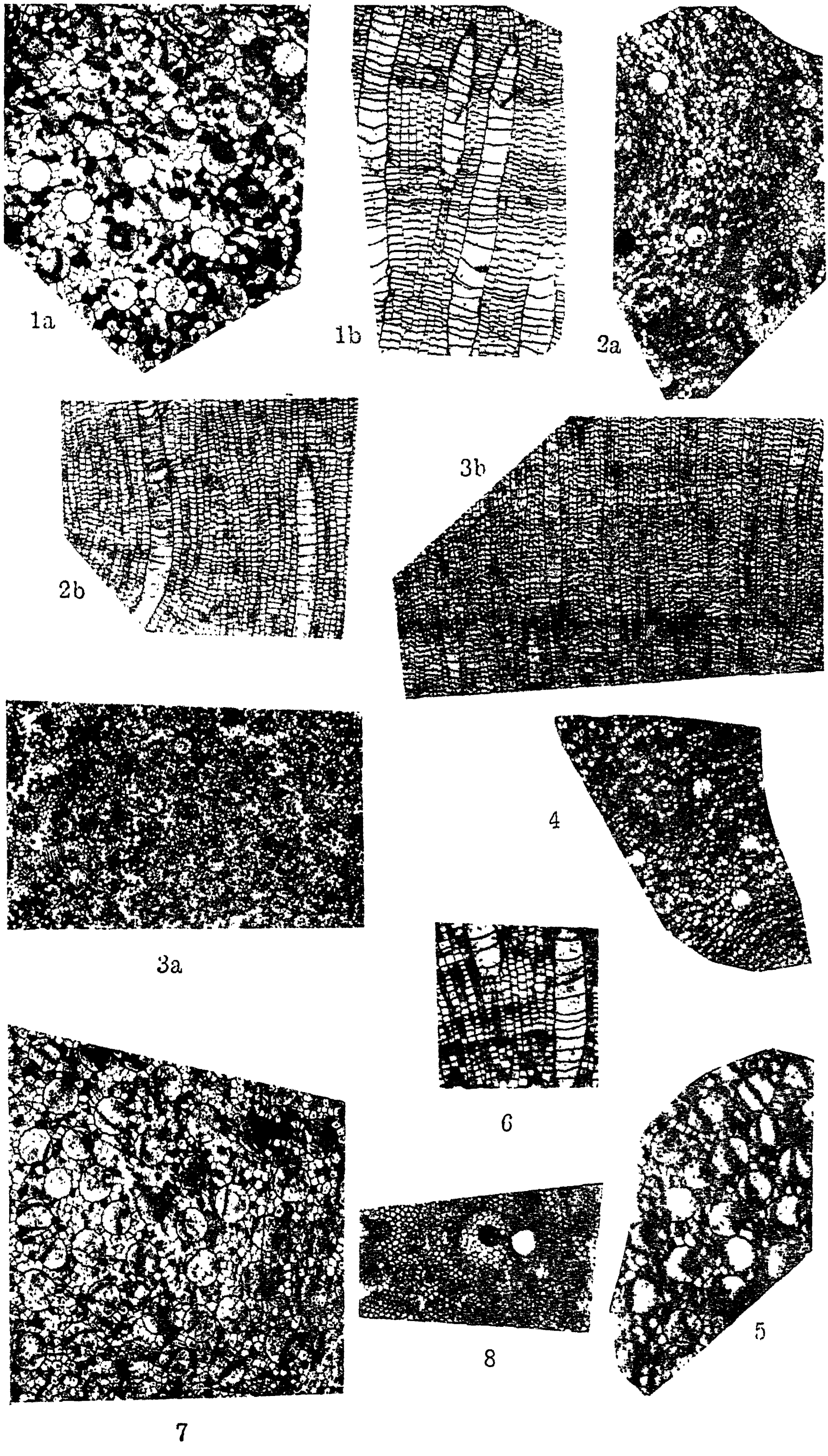
Fig. 6.—F 3466, University of Queensland. Recent. Great Barrier Reef.



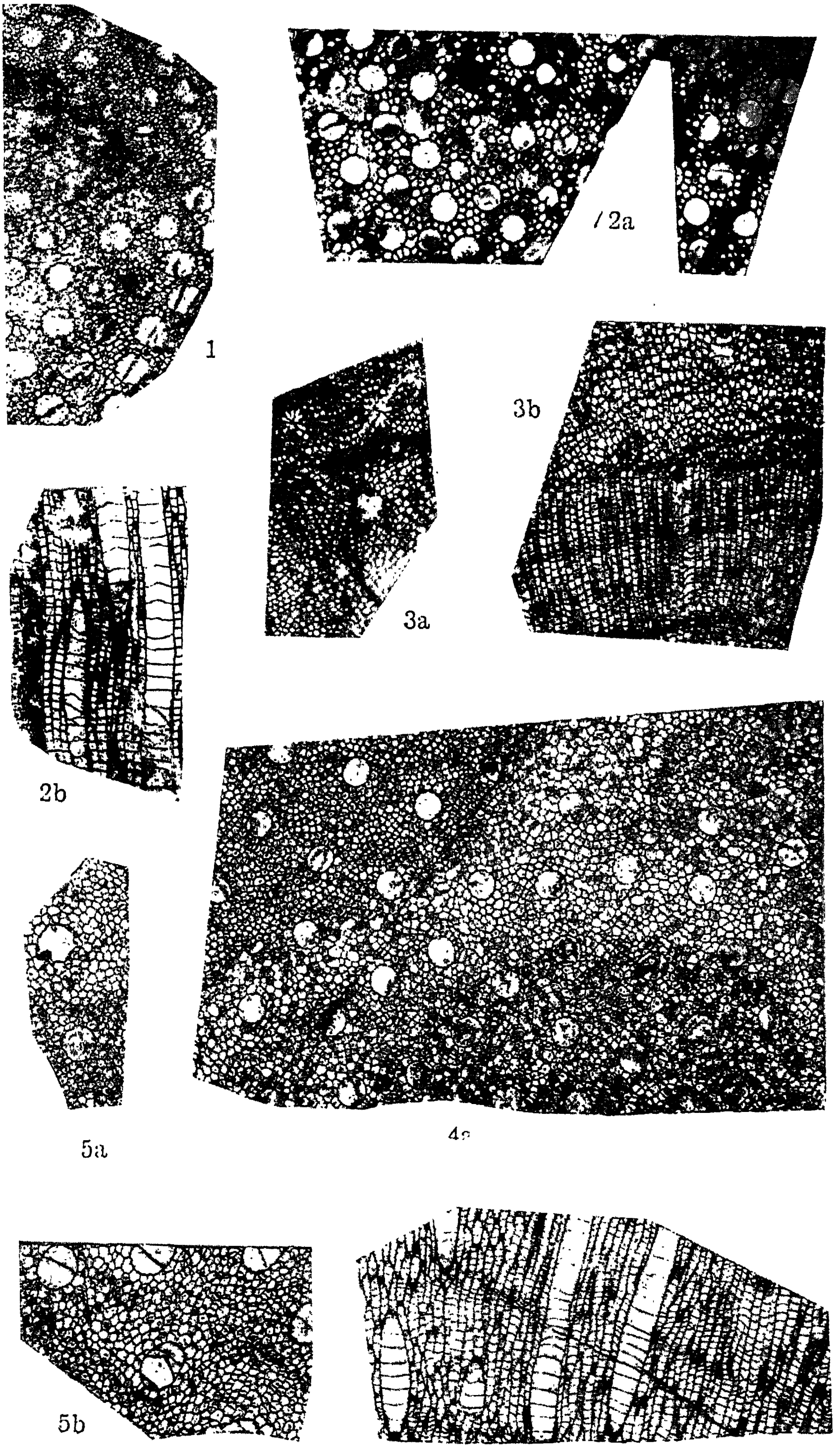
Heliolites daintreei Nicholson and Etheridge.



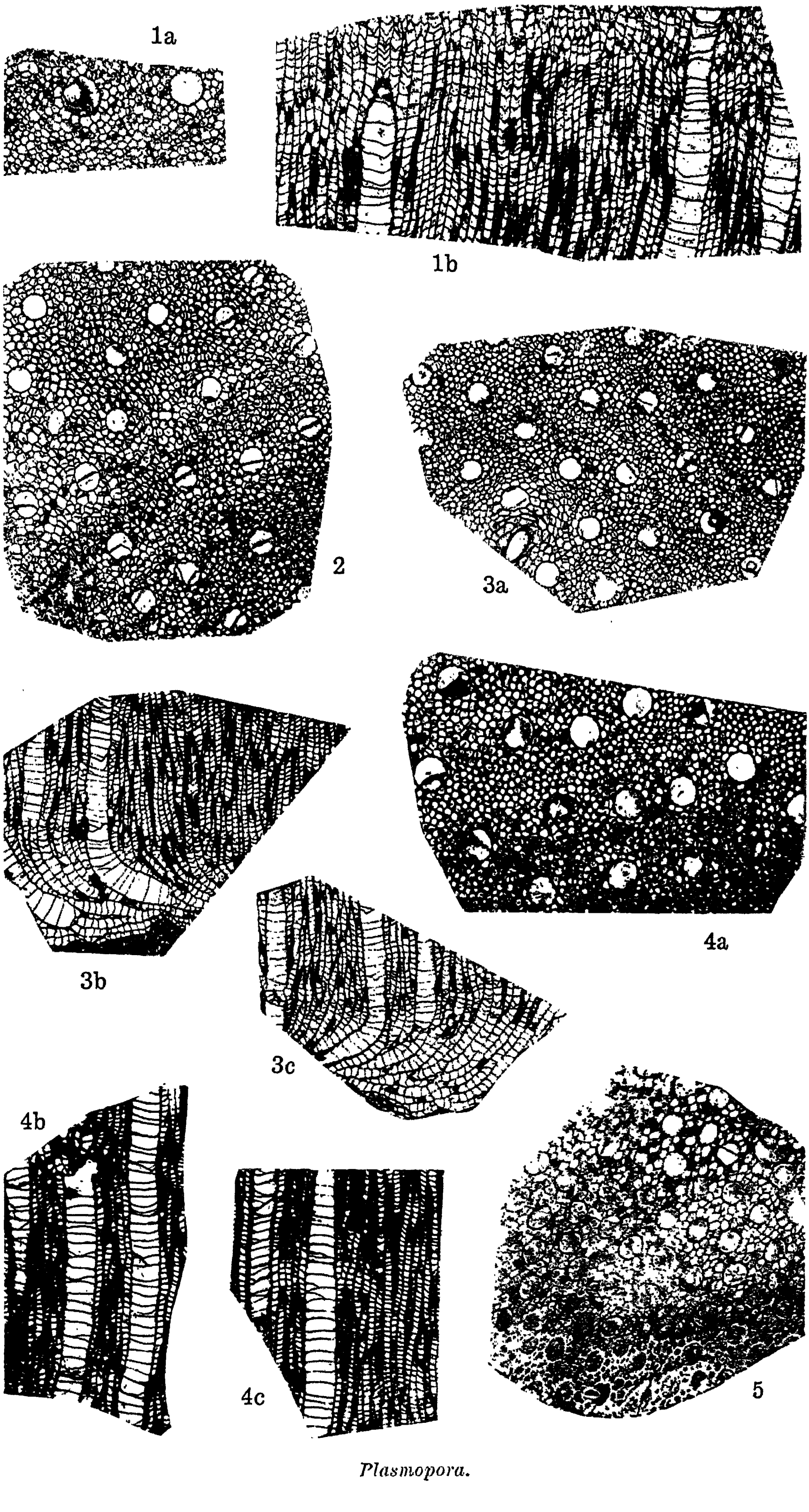
Heliolites daintreei Nicholson and Etheridge.



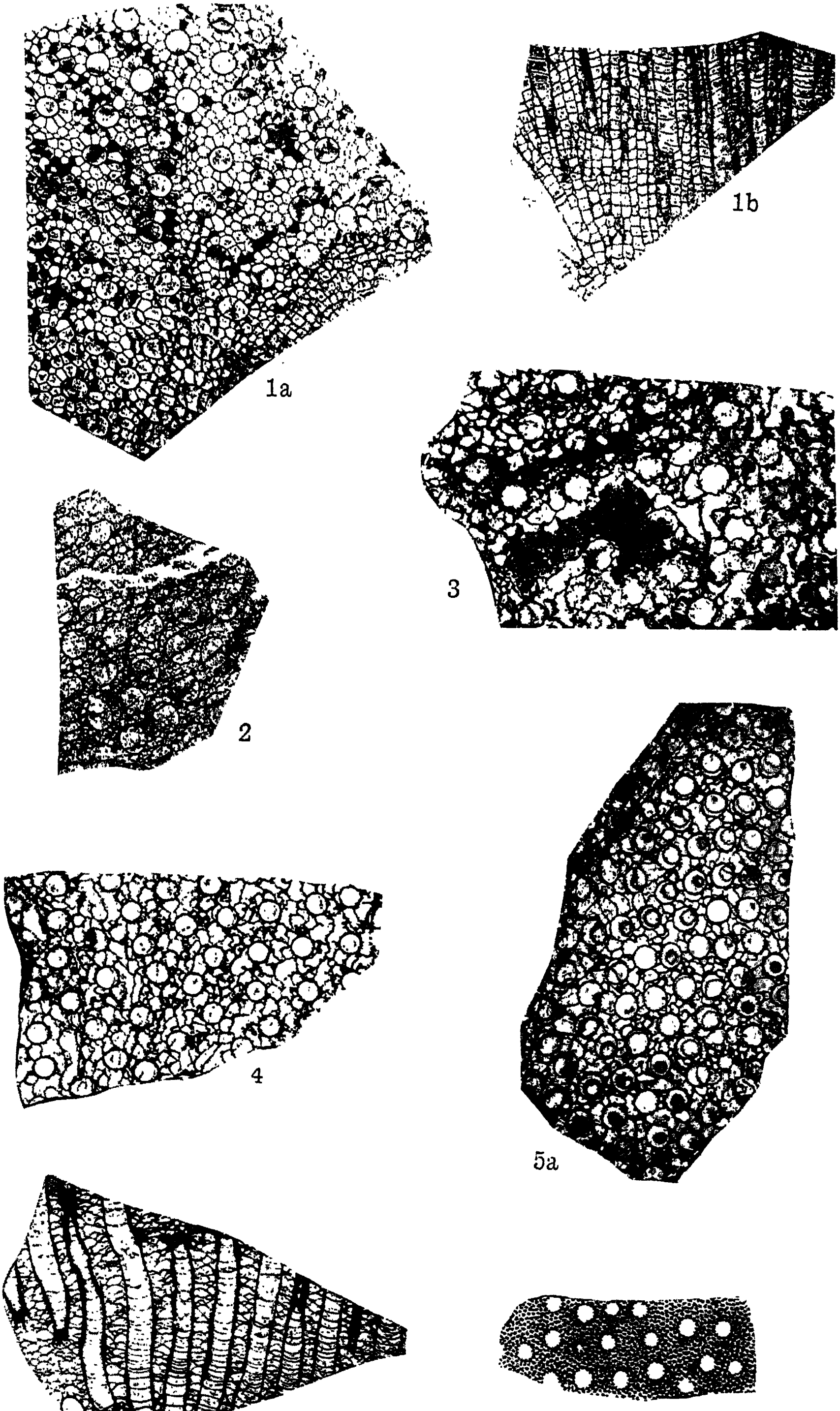
Heliolites daintreei Nicholson and Etheridge.



Heliolites and *Plasmopora.*



Plasmopora.



Plasmopora, Propora and Heliopora.

The Royal Society of Queensland.

Report of Council for 1938.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1938.

Thirteen original papers were read or tabled at Ordinary Meetings, and accepted for publication in the Proceedings; four lectures were given; two meetings were devoted to symposia, and one to exhibits. The average attendance at meetings was forty, and suppers were served at a small charge to members.

Because of the large cost of the previous year's volume, the Council in the earlier part of the year found itself unable to accept for publication many papers submitted. The effect of this position was placed before the Honourable the Premier with a request for the renewal of the subsidy for printing hereto enjoyed by the Society. The Council is pleased to report that the proposal was received favourably, and the Government decided that the Chief Secretary's Department will pay a subsidy on the basis of £ for £ up to a maximum of £150 per annum for the publication by the Government Printer of those papers which, in the opinion of a responsible officer of any Government Department, are of value from a Government point of view. As a result of this ten papers were presented at the last meeting of the Society in the year. This renewed support of the Society by the Government is most gratifying; the subsidy paid last year for the 1937 volume in terms of this decision was £110. The Council acknowledges with gratitude the grant of £50 from the Walter and Eliza Hall Fund of the University towards the cost of publication of one of the papers in that volume.

There are at present 5 honorary life members, 5 life members, 3 corresponding members, 190 ordinary members and 1 associate member. This year we have lost by death 6 members, and by resignation 1; 6 new members were elected.

The library committee has made considerable progress in the arrangement of periodicals, and has much pleasure in reporting that by the generosity of Prof. J. V. Duhig, 45 volumes of Proceedings of the Royal Society of London have been bound. Two hundred and ten periodicals were obtained by exchange.

The President and Dr. F. W. Whitehouse represented the Society at the twenty-fourth A.N.Z.A.A.S. meeting at Canberra.

Attendance at council meetings was as follows:—L. S. Bagster, 7; E. W. Bick, 9; J. V. Duhig, 6; D. A. Herbert, 8; D. Hill, 10; H. A. Longman, 4; F. A. Perkins, 9; H. C. Richards, 10; A. R. Riddle, 6; H. V. Seddon, 5; J. H. Smith, 6; M. White, 6; F. W. Whitehouse, 8.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31ST DECEMBER, 1938.

Cr. **Dr.**

RECEIPTS.

	£	s.	d.
Balance in Commonwealth Bank, 31st December, 1937	66	13	0
Subscriptions	149	2	0
Sales, Reprints and Volumes	1	9	4
Subsidy from Walter and Eliza Hall Fund, per University, on cost of printing paper by S. T. Blake	50	0	0
Interest on Commonwealth Loan	4	11	3
Savings Bank Interest	2	8	0
Refreshments, Account, Collections	2	10	3
Refund, from Librarian	0	16	7
Members' Donations to J. F. Bailey Memorial Fund ..	2	2	0
	£279	12	5

EXPENDITURE.

	£	s.	d.	£	s.	d.
Government Printer, Abstracts and Report				12	1	0
Government Printer, 1937 Volume of Proceedings	308	12	8			
Less paid December, 1937 ..	100	0	0			
Less paid as subsidy by Chief Secretary's Department, September, 1938	110	0	0			
				98	12	8
State Government Insurance (Library)				1	1	7
J. F. Bailey Memorial, £2 2s.; Members, £2 2s. ..				4	4	0
Hon. Secretary, Postages				8	18	9
Hon. Librarian, Postages				2	0	0
Hon. Treasurer, Postages and Duty				1	2	0
Lanternist				0	10	6
Refreshments				4	9	6
Bookbinding (W. Deacon)				8	2	0
Balance in Commonwealth Bank				138	10	5
				£279	12	5

A. J. STONEY, B.E.E., Hon. Auditor.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 27th March, 1939.

The Annual General Meeting was held in the Geology Lecture Theatre of the University on Monday, 27th March, 1939, at 8 p.m. The President, Professor H. C. Richards, welcomed the Patron of the Society, His Excellency the Governor, Sir Leslie Orme Wilson, P.C., G.C.S.I., G.C.M.G., LL.D. The minutes of the previous annual meeting were read and confirmed. The Annual Report was adopted on the motion of Dr. W. H. Bryan, who suggested that a list of papers presented to the Society during the year should be included in the Report, and that those receiving the Government subsidy be indicated. The Balance-sheet was received. A. L. Reimann, Ph.D., D.Sc., G. P. D. Boissard, B.Sc., and Miss Patricia Marks, B.Sc., were nominated for Ordinary Membership. The following Officers and Council were elected for 1939:—President, Mr. H. A. Longman; Vice-Presidents, Professor H. C. Richards and Professor J. V. Duhig; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Miss D. Hill; Hon. Librarian, Mr. F. A. Perkins; Hon. Editors, Dr. D. A. Herbert and Mr. J. Harold Smith; Members of the Council, Dr. E. O. Marks, Mr. A. R. Riddle, Dr. F. H. S. Roberts, Professor H. R. Seddon, and Dr. M. White. Mr. A. J. Stoney was elected Auditor. The retiring President, Professor H. C. Richards, then inducted the President-Elect, Mr. H. A. Longman, to the Chair. The new President then called on the retiring President to deliver the address "Scientific Researches Affecting Queensland." Sir Leslie Wilson expressed to Professor Richards the thanks and appreciation of the meeting, and was supported by Professor J. K. Murray.

Abstract of Proceedings, 24th April, 1939.

The Ordinary Monthly Meeting of the Society was held in the Geology Theatre of the University on Monday, 24th April, at 8 p.m., with the President in the Chair. About sixty members and guests were present. The minutes of the previous Ordinary Meeting were read and confirmed. I. R. Bick, B.Sc., A. L. Reimann, Ph.D., D.Sc., G. P. D. Boissard, B.Sc., and Miss Patricia Marks, B.Sc., were unanimously elected Ordinary Members of the Society. Professor S. F. Lumb, D.D.S., L.D.S., and F. W. Arden, M.D., B.S., F.R.C.P., were proposed for Ordinary Membership.

The chief business of the evening was an address by Professor W. K. Gregory, of the American Museum of Natural History and Columbia University, entitled "The Origin of the Human Dentition." In his address, which was fully illustrated with a series of lantern slides, Professor Gregory concisely reviewed the long lineage of the vertebrates, culminating in the higher mammals. He briefly referred to the divergent views of the lines of human ancestry expressed by Professor F. Wood Jones and the late Professor H. F. Osborn. The distinctive value of recent discoveries by Professor Raymond Dart and Dr. R. Broom of "Australopithecine Man-apes" in South Africa was outlined. Professor Gregory also referred to the significance of the *Sinanthropus* remains found near Pekin. A masterly exposition of the chief dental characteristics of these fossils, in comparison with modern man, was a special feature of the lecture. Cumulative evidence

supported the view that man, like his less ambitious cousins, the modern anthropoid apes, is a descendant of the late Tertiary ape stock of Europe, Asia, and Africa.

A vote of thanks was moved by Professor E. J. Goddard, seconded by Professor H. J. Wilkinson, and supported by Professors S. F. Lumb and J. V. Duhig and Mr. R. L. Donnan (visitor).

Abstract of Proceedings, 29th May, 1939.

The Ordinary Monthly Meeting of the Society was held in the Geology Theatre of the University on Monday, 29th May, at 8 p.m., with the President in the Chair. About forty members and friends were present. The minutes of the previous meeting were read and confirmed. Professor S. F. Lumb, D.D.S., L.D.S., and F. W. Arden, M.D., B.S., F.R.C.P., were elected Ordinary Members. Miss Margaret Cross, B.Sc., was proposed for Ordinary Membership.

The following papers were read:—

(*a*) "The Absorption of Acids by Wool," by L. S. Bagster, D.Sc., and Madoline V. Connah, M.Sc.

The absorption by wool of hydrochloric, acetic, and chloracetic acids was studied, the acids acting singly and in pairs. Singly the first three are absorbed to about the same extent, but almost 50 per cent. more chloracetic is absorbed. However, when chloracetic acid is mixed with sulphuric or hydrochloric acid, it is only slightly absorbed, like the weak acetic acid.

In commenting on the paper Mr. H. Tryon offered some remarks on the absorption of organic acids by wool.

(*b*) "Habits and Chaetotaxy of the Larva of *Anopheles* (*Anopheles*) *atratipes*, Skuse," by Elizabeth N. Marks, B.Sc.

Larvae of this species, previously known only from Dunwich, Stradbroke Island, are herein recorded from Nudgee, Redcliffe, and Bribie Island in varying habitats. A full account of the chaetotaxy of the larva is given, and certain variations from the original brief description by Mackerras are pointed out.

Mr. F. A. Perkins and Mr. H. Tryon commented on the paper.

Dr. F. H. S. Roberts gave a lecture "Parasite Control Overseas."

Dr. Roberts discussed the position of parasite control in overseas countries, particularly in the United States, Great Britain, Holland, France and South Africa, which countries he had recently visited. After giving some idea of the status of parasitology in these countries, the speaker dealt with a number of parasite problems, giving most attention to those problems which are of interest to Australia. Blowflies in sheep, ticks on cattle and other animals, lice on sheep and goats, worms in sheep, pigs and horses, were mentioned, and some idea given of the importance of these pests in other countries and of the steps taken to control them.

A vote of thanks to the lecturer was moved by Mr. F. A. Perkins, seconded by Mr. J. H. Smith, supported by Prof. H. C. Richards, and carried by acclamation.

Dr. D. A. Herbert exhibited specimens of *Galinsoga parviflora* showing the effects of a new virus disease (Galinsoga virus 1) transmitted by *Myzus persicae*. The symptoms are similar to those produced in other plants by Beta virus 1, a leaf roll accompanied by the production of protruberances on stems and the lower sides of leaves. A specimen of *Lilium longiflorum* suffering from lily mosaic (Cucumis virus 1) was also exhibited.

Abstract of Proceedings, 26th June, 1939.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 26th June, at 8 p.m., with the President in the Chair. About fifty members and friends were present. The minutes of the previous meeting were read and confirmed. Miss M. Cross, B.Sc., was unanimously elected an Ordinary Member. Professor W. K. Gregory, of the United States National Museum and Columbia University, New York, was nominated as a corresponding member, and Mrs. H. S. McKee, M.A., as an Ordinary Member.

The business of the evening was a series of exhibits. Professor L. S. Bagster showed Liesegang rings formed by precipitation reaction in a jelly where one reagent diffuses in to react with a second reagent already in the jelly. The formation of separate bands of precipitate with clear sections between is characteristic of many reactions. The explanation is in doubt but the process is possibly due to supersaturation with later diffusion to points of precipitation leaving free sections. These rings have been used to explain the concentric banding of agate.

Dr. F. W. Whitehouse exhibited tabular cherts interbedded with Cambrian limestones in Western Queensland, the surface of the cherts being marked with raised, concentric structures suggesting some form of Liesegang rings. Other cherts from this region had the concentric markings in coloured bands and not in raised rings. He referred also to the precious opal deposits of parts of Australia (the silica apparently replacing limestone) where the opal is horizontally banded in Liesegang fashion and only certain alternating bands had the optical characters that gave the play of colours.

Dr. W. H. Bryan exhibited—(1) A spherulite from Tamborine Mountain with a regularly concentric structure suggesting rhythmic precipitation of the felspar film from a colloidal solution; (2) orbicular granite from Nelson, New Zealand, collected by Dr. P. Marshall and in which the alternating concentric structures might be due to oscillatory crystallization; and (3) a specimen of regularly banded sandstone from the flank of Mount Barney in which the rhythmic pattern was suggestive of seasonal deposition.

Mr. S. T. Blake exhibited specimens of a few species of grasses and one sedge, of varied interest, chiefly from the more arid districts, some representing new records for Queensland, others aiding in the better understanding of forms hitherto poorly understood. Specimens from the Sand Desert were included.

Mr. Kenneth Jackson exhibited—(*a*) Five boomerangs, illustrating a type of decorative art consisting of criss-cross, diamond and triangular patterns scratched on a smoke-blackened background; their range

apparently extended from the Burnett River and Fraser Island in the north to the Clarence River in the south and west to the McIntyre River; (*b*) A wooden sword, hitherto unrecorded, from the Brisbane district, 35½ inches in length by 3¼ inches in width of the blade. This was obviously used as a hand weapon, being too unwieldy for throwing.

Mr. Callaghan exhibited an experimental photoelectric colorimeter built by himself, in an attempt to improve the accuracy of colorimetric technique. Despite reports from elsewhere that an accuracy of at least one half per cent. could be obtained by means of this method, it had not been found possible to achieve better than 2 or 3 per cent. so far. The principle used was to pass an adjustable beam of light through the solutions under test, which was contained in an optical cell of pyrex glass with fused joins; the light then fell on a Weston photronic photoelectric cell, the output of which was measured by means of a Cambridge Spot Galvanometer. Owing to the fact that cells of the "barrier-layer" type employ a secondary effect, which was not properly understood, the readings obtained could not be reproduced accurately; that is, the instrument was somewhat unstable. A number of alternative arrangements were described, and their difficulties pointed out. Mr. Callaghan intimated his intention of trying out a vacuum type photocell, which should give better results.

On behalf of Dr. M. White, Mr. I. Bick exhibited the fleece of a sheep which was used in a recent feeding experiment.

In the course of some drought-feeding experiments it became necessary to determine how long grown-sheep could be kept on a diet almost free from fibre, but rich in protein. Sheep fed nothing but commercial meat-meal (65 per cent. protein) have been kept in good health for six months. The length and quality of the staple are remarkable. Over an inch was grown in three months. The wool is bright, attractive, "handles" well, and shows not sign of "tenderness."

Mr. E. V. Robinson exhibited *Conularia* sp. from probable Permo-Carboniferous beds in the lower Stanley River Valley portion 89 Moreton Sheet 19N. This would represent the third block of Permo-Carboniferous sediments found in the Brisbane Valley during the last few years.

Mr. F. A. Perkins exhibited five living specimens of *Peripatoides leuckarti* Sang. Three of these were collected at Albert River on the 10th April, 1939, and two at Binnaburra on the 25th May. One of the specimens collected at Albert River gave birth to two young, one of which is still alive. It has increased in length from 6 mm. to 20 mm. in two months.

The President, Mr. H. A. Longman, exhibited a small fragment of abraded bone which had been discovered by Mr. John Wadley in the Walloon Sandstones near the Brisbane River, below Lowood. This was the first discovery of a vertebrate fossil in these extensive sandstones. The bone was almost entirely embedded in a large mass of sandstone. Although the fragment did not afford fully satisfactory evidence, Mr. Longman tentatively identified it as portion of the upper jaw, with alveoli of small teeth, of a very large amphibian, probably one of the Stegocephalians.

Mr. Longman also exhibited the skeleton of a long-tailed dormouse phalanger *Eudromicia macrura* from Jordan Creek, West Palmerston, via Innisfail; collected by Mr. J. Rawnsley and forwarded by Mr. C.

Thomas. This was the first specimen to be received at the Queensland Museum. Four specimens were collected on the Atherton-Herberton tableland in 1913 by Dr. Eric Mjoberg, who described the species in 1915.

Comments on the exhibits were made by Mr. Longman, Mr. Tryon, Dr. Marks, Mr. Callaghan, Mr. Gipps, Mr. Perkins, Professor Duhig, and Dr. Whitehouse.

Abstract of Proceedings, 31st July, 1939.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 31st July, at 8 p.m., with the President in the chair. About thirty members and friends were present. The minutes of the previous meeting were read and confirmed. Professor W. K. Gregory was elected a corresponding member, and Mrs. H. S. McKee, M.A., was elected to ordinary membership.

In the unavoidable absence of Dr. A. L. Reimann, a lecture was given by Dr. F. W. Whitehouse, who chose as his subject "The Morphology and Evolution of the Trilobites." A vote of thanks, moved by Dr. E. O. Marks, and supported by Messrs. Ogilvie, Perkins, and Tryon, was carried by acclamation.

Abstract of Proceedings, 28th August, 1939.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 28th August, at 8 p.m., with the President in the chair. About twenty-five members were present. The business of the evening was a lecture by Dr. A. L. Reimann, "Thermionic Phenomena and their Applications."

The early history of the development of the thermionic valve was traced and the main phenomena exhibited by valves were surveyed, including space charge, saturation, the effects of residual gases, and the relation between thermionic activity and electro-positiveness of the emitter. An outline of the theory of thermionic emission was then given, use being made of the gravitational analogue of a potential hill in explaining the action of the electron-retarding field in the region of the surface of a metal. Physical reasons were given for the existence of this field and it was shown how it is modified by the presence of an adsorbed electropositive or electronegative contamination at the surface.

An outline was given of the development of emitting cathodes in commercial valves and the main commercial and scientific applications, viz., valves, Coolidge X-ray tubes, vapour lamps, cathode-ray tubes, and the electron microscope were listed and briefly explained.

The cooling of a filament associated with the latent heat of evaporation of electrons and the operation of a laboratory sodium-vapour lamp were demonstrated.

Dr. W. H. Bryan, Mr. A. R. Riddle, Mr. J. H. Smith, and Mr. F. C. Bennett took part in the discussion which followed, and a vote of thanks to the lecturer, moved by Dr. T. G. H. Jones and seconded by Mr. Riddle, was carried by acclamation.

Abstract of Proceedings, 25th September, 1939.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 25th September, at 8 p.m., with the President in the Chair. Twelve members were present. A. Stanley Roe, B.A., M.B., B.Ch. (Oxon.), F.R.A.C.S., was proposed for Ordinary Membership.

Mr. S. T. Blake, M.Sc., read a paper entitled "The Interrelationships of the Plant Communities of Queensland," of which the following is a summary:—The various vegetation types in Queensland are determined chiefly by soil type, which in its turn depends chiefly on rock type, more or less modified by topography. Except in extremes rainfall and other climatic factors appear to be of only secondary importance. In many cases the lines of demarcation between vegetation types are remarkably sharp, and different examples are given. Further, our vegetation is a dynamic thing and many changes are at present in progress. Some of these appear to be due to cyclic variations in the salt content of the soil. There is no evidence for the belief that the desert areas are expanding.

Mr. Blake also read a paper entitled "Notes on Cyperaceae III," in which about 30 species of different genera of Cyperaceae are discussed, of which 9 are described as new.

Messrs. F. C. Bennett, C. E. Ogilvie and F. Gipps took part in a discussion on these papers.

In the absence of the author, a paper, "A Revision of the Australian Arctiidae (Lepidoptera)" by A. Jefferis Turner, M.D., F.R.E.S., was tabled.

Mr. Tryon, after paying a tribute to Dr. Turner's eminence as a specialist, regretted that no mention was made of the work of the late Dr T. L. Lucas, especially that on Arctiidae in the Brisbane district, which had "especial value for local students." He thought that the location of type specimens should be given. It was disappointing to find no references to life-histories, but only descriptions of adults.

Subsequently Dr. Turner informed the Hon. Secretary that the types were actually the property of the C.S.I.R., and will eventually go to Canberra. He said that little was known of the larval stages, which would provide material for future workers. In his paper errors had been corrected and synonymy adjusted concisely without criticism or discussion of previous workers, which would have added much to its length but "nothing to its scientific value or to the dignity of your proceedings."

Mr. J. H. Smith, M.Sc., showed a case prepared by the Department of Agriculture, to illustrate a method of control for the Bean Fly pest. Mr. Tryon commented on the exhibit. The President exhibited a basket of eggs which had been replaced by travertine.

ABSTRACT OF PROCEEDINGS, 30TH OCTOBER, 1939.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 30th October, at 8 p.m., with the President in the Chair. About thirty members were present. The President welcomed Mr. C. T. White on his return from Kew. A. Stanley Roe, B.A., M.B., B.Ch. (Oxon.), F.R.A.C.S.. was unanimously elected an Ordinary Member.

Professor H. C. Richards, D.Sc., addressed the meeting on the Sixth Pacific Science Congress, held in San Francisco in 1939. He outlined the history of Pacific Science Congresses and their organisation, and the activities of the Sixth Congress, mentioning some of the outstanding personalities. He urged strongly that (1) Australia should send a worthy delegation to every important scientific congress held in and about the Pacific, because it was of great importance to Australia to co-operate fully with scientific investigations in the area, and (2) as a matter of sound policy, those responsible for the selection of the delegation should take care to associate some of the young established research workers on whose shoulders at a later date would fall the duty of senior representation.

A vote of thanks to the speaker was moved by Prof. Duhig, seconded by Prof. Seddon, supported by Mr. C. E. Ogilvie, and carried by acclamation.

ABSTRACT OF PROCEEDINGS, 27TH NOVEMBER, 1939.

The Ordinary Monthly Meeting of the Society was held in the Lecture Theatre of the Department of Geology of the University on Monday, 27th November, at 8 p.m., with the President (Mr. H. A. Longman) in the Chair. About twenty members were present. The minutes of the previous meeting were read and confirmed. Mr. J. W. Bleakley, Director of the Department of Native Affairs, and Mr. V. Grenning, Director of the Forestry Department, were proposed for Ordinary Membership.

The following papers were read:—

(*a*) "Notes on Australian Muscoidea V. Calliphoridae," by G. H. Hardy.

(*b*) "A Survey of the Ectoparasites of Dogs in Brisbane, Queensland," by F. H. S. Roberts, D.Sc.

(*c*) "The Middle Devonian Rugose Corals of Queensland, II. The Silverwood-Lucky Valley Area," by Dorothy Hill, M.Sc. Ph.D.

(*d*) "Studies on Queensland Grasses, Part 1," by S. T. Blake, M.Sc., Walter and Eliza Hall Fellow in Economic Biology.

(*e*) "Notes on Cyperaceae IV.," by S. T. Blake, M.Sc., Walter and Eliza Hall Fellow in Economic Biology.

(*f*) "The Heliolitidæ of Australia, with a discussion of the morphology and systematic position of the family," by O. A. Jones, M.Sc., and Dorothy Hill, M.Sc., Ph.D.

Obituary.

John Frederick Bailey, who died on 19th May, 1938, aged seventy-two years, was a son of Frederick Manson Bailey, C.M.G., whose name will forever be associated with Queensland Botany.

He was a member of the Society for nearly fifty years and from 1894 until 1906—a very difficult period in part—he was Honorary Secretary. In 1910 he occupied the Presidential Chair, but in 1917 upon appointment to the Directorship of the Botanic Gardens at Adelaide, resigned a corresponding position in Brisbane as well as the post of Government Botanist.

In 1932, upon retirement from the Adelaide post, Mr. Bailey returned to Brisbane and resumed active associations again with the Society until his death.

C. A. Lambert was a member for over a quarter of a century from 1912 until his death during 1938.

His special interest was microscopy in which he found relaxation after his duties as a banker. During his term of membership he was seldom able to attend meetings owing to residence in places other than Brisbane, but it is on the constant and loyal support of members such as Mr. Lambert that the Society is able to base its activities.

Leonard Canton Morris, B.E. (Syd.), A.M.I.E. (Austr.), A.M.I.E.E. (Lond.), died on 24th November, 1938, aged sixty years. After a distinguished course in electrical engineering in the University of Sydney he was appointed Deputy Lecturer in Physics at the Technical College, Sydney, but in 1909 was appointed Superintendent of the Technical College, Brisbane, and Superintendent of Technical Education in 1914, which post he held until his death.

Travis Rimmer, M.Sc., who died on 7th July, 1938, aged fifty-seven years, was an Englishman who graduated in the University of Manchester. After filling Government positions in Fiji, he was appointed Assistant Lecturer in Physics in the University of Queensland in 1921, subsequently being appointed to a full lectureship in Physics and Meteorology. For the last three years before his death Mr. Rimmer was engaged in important meteorological researches in connection with long-range forecasting. This was done in terms of the Commonwealth funds provided through the Council of Scientific and Industrial Research to the University.

William Nathaniel Robertson, C.M.G., C.B.E., M.B., Ch.M., F.R.A.C.S., F.C.S.A., died on 12th June, 1938, at the age of seventy-two years. His medical services to invalided returned soldiers and as Vice-Chancellor of the University of Queensland for many years will always be remembered.

Dr. Robertson was a most public spirited man and played a prominent part in building up the Australian Royal College of Surgeons, of which he was a foundation fellow. Although he did not join the Society till six years before his death, his attendance was frequent, and at all times he gave of his best in furthering the objects for which the Society strove.

Eustace Russell, M.D., M.R.C.P., died at the age of fifty-four years on 23rd December, 1938. He was a member of the University Senate and was a part-time lecturer in the Faculty of Dentistry. For seventeen years he had been an Hon. Physician at the Brisbane General Hospital.

Dr. Russell's membership of the Society dated from 1924.

Publications are being received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

ALGERIA—
Societe de Geographie et d'Archaeologie d'Oran.

ARGENTINE—
Universidad Nacional de la Plata.

AUSTRALIA—
Commonwealth Bureau of Census and Statistics, Canberra.
Department of Agriculture, Melbourne.
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VOLUME LII., PART 2.

VOL. LII., No. 7.

NOTES ON AUSTRALIAN CYPERACEAE, V.

By S. T. BLAKE, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 25th November, 1940.*)

In this paper are described seven new species from the genera *Bulbostylis, Fuirena,* and *Schoenus.* The types are deposited in the Queensland Herbarium, Brisbane, and except in the case of *Schoenus elegans,* duplicates (isotypes) are being distributed.

The abbreviations used for different herbaria are as follows:—

Herbarium of J. M. Black, Adelaide	BL.
Queensland Herbarium, Botanic Gardens, Brisbane ..	BRI.
Herbarium of J. B. Cleland, University of Adelaide ..	CL.
National Herbarium of Victoria, Melbourne	MEL.
National Herbarium of New South Wales, Sydney ..	NSW.

Where there is no special indication, the specimens are in the Queensland Herbarium.

Bulbostylis pyriformis *S. T. Blake*; species nova, a congeneris nuce pyriformi trisulcata differt.

Herba annua, glaucescens, leviter odorata. *Culmi* fasciculati, patentes vel erecti, stricti vel curvuli, rigidi, subtrigoni vel compressi, pluristriati, ad costulas albidas pilis rigidis patulis albidis basi leviter tuberculatis praediti, apice ipso densiuscule hispidi, usque ad 18 cm. longi, 0.35–0·65 mm. crassi. *Folia* pauca, brevia, caulinum plerumque unicum; vaginae tenuiter membranaceae, albo-hyalinae, dorso herbaceae, omnino striatae, praecipue nervis breviter albo-pilosae, ore oblique secto pilis tenuissimis longis albis ± crispis densiuscule praeditae; laminae angustissimae, fere planae, apice subulatae, subtus 1–3 nerves haud carinatae, marginibus incrassatis scabrae, usque ad 22 mm. longae, nonnunquam brevissimae. *Anthela* simplex, 1–5 spiculosa. *Bracteae* spicula breviores, glumiformes sed 1–2 laminam subulatam brevissimam praeditae et sub laminae basi longe ciliatae. *Radii* breves, rigidi, robusti, angulati, scabro-ciliolati, usque ad 5 mm. longi, saepe patuli vel leviter decurvati, e prophyllo brevi pilosulo ore oblique secto orti. *Spiculae* oblongo-ovatae vel lanceolatae, fusco-castaneae, manifeste angulatae, pluriflorae, 5–10 mm. longae, 2–3 mm. latae. *Glumae* laxe spiraliter imbricatae, ovatae, apice subtriangulares subobtusae, breviter apiculatae vel superiores fere muticae, incurvae, appressae, manifeste carinatae carina 3–nervi viridi vel pallescenti asperulae vel scaberulae, lateribus tenuiter membranaceae, enerves, castaneae vel fuscescentes, pubescentes, marginibus ciliolatae, 2·8–3·2 mm. longae. *Stamina* 3; antherae flavae, oblongae, prominule rubro-apiculatae, 0·5–0·6 mm. longae. *Stylus* tenuis, glaber, 1·1–1·2 mm. longus; stigmata 3, pilosula, stylo subaequilonga. *Nux* albida vel straminea, vix nitida, ambitu late pyriformis, apice truncata vel emarginata, apiculata, sub medio subito angustata, omnino aeque trigona, manifeste tricostata, lateribus angulos versus convexa sed medium versus concava, plerumque verrucosa, obscure transversim undulata, cellulis extimis breviter verticaliterque oblongis inconspicuis, toro brevissimo annuliformi, 1·4–1·3 mm. longa, 1 mm. lata; stylo-basis bulbiformis vel ± pyramidalis, 0·2–0·3 mm. longa lataque, pallida vel brunnescens, mox caduca.

QUEENSLAND.—North Kennedy District: Charters Towers, on sandstone ridge in *Eucalyptus-Acacia* forest, 1,100–1,200 feet, June 11th, 1936, *Blake* 11701. Warrego District: Gilruth Plains, east of Cunnamulla, at edge of timbered sandhill, ca. 600 feet, May 19th, 1939, *Blake* 14045 (TYPE).

The style-base falls away from the nut very early, so that the chief generic character is sometimes liable to be overlooked. The nut is quite unlike that of other species of *Bulbostylis* in being strongly constricted below the middle and in the vertically furrowed faces, and resembles that of *Fimbristylis trigastrocarya* F. Muell. However, the style does not fall away in its entirety, but is deciduous above its base which is left as the characteristic "button" usual in *Bulbostylis*, while the characteristic needle-like hairs at the mouth of the leaf-sheaths and the few-ranked, pubescent, incurved glumes are quite those of this genus.

The specimens from Charters Towers have smaller, darker coloured, less apiculate nuts, 1·25 mm. long and 0·9 mm. broad. Sometimes also, one of the bracts is longer than the inflorescence. The relatively few specimens are, however, not entirely satisfactory, as they bear for the most part either immature or overmature spikelets.

Bulbostylis turbinata *S. T. Blake*; species nova, affinis *B. capillari* (L.) C. B. Clarke, sed culmis pilosulis, glumis glabris mucronatis, nuce alba symmetrica turbinata (basi cuneata) apice abrupte acuminata, differt.

Herba annua, gracilis, usque ad 15 cm. alta, admodum glaucescens. *Culmi* fasciculati, erecti vel obliqui, stricti vel curvuli, filiformes et 0·25–0·4 mm. crassi, 4–7–costati, costis sparse vel densiuscule hispiduli pilis albis saepe e tuberculis parvis ortis. *Folia caulina* 1–2; vaginae tenues, dorso herbaceae, antice hyalinae, valide nervosae nervis setulosis, ore oblique secto pilis tenuissimis longis barbatae vel nonnunquam fere glabrae; laminae usque ad 5 cm. longae, 0·2–0·3 mm. latae, apice acutae ± incrassatae, subplanae vel admodum involutae, subtus 1–nerves, nervi cum marginibus costiformibus hispidulae, ceterum glabrae, laeves. *Anthela* laxa, simplex, plerumque 2–4–spiculata. *Bracteae* 1–2, foliis subsimiles, spicula breviores vel inferior aliquantum longior raro anthelam superans. *Radii* usque ad 3, filiformes, subaequales, patuli vel subdeflexi, usque ad 10 mm. longi. *Spiculae* solitariae, castaneae vel castaneo-brunneae, lanceolatae vel lineares, acutae, angulatae, 6–8 mm. longae, 1·5–1·7 mm. latae; rhachilla tenuis, flexuosa, alata. *Glumae* (infima bracteoliformi persistenti sterili excepta) cymbiformes, ovatae, acutae, mucronatae, squarrulosae, valde carinatae carina straminea vel viridi 3–nervi ± scaberula breviter excurrente, lateribus hyalinae, brunneo-tinctae, glabrae, marginibus integerrimae vel sursum minutissime ciliolatae, 2 mm. longae. *Stamina* 3; antherae inclusae, flavae, anguste oblongae, minute et obtuse apiculatae, 0·25 mm. longae. *Stylus* filiformis, glaber, 0·5 mm. longus; stigmata 3, stylo aequilonga. *Nux* candida, turbinata, prope basin abrupte attenuata, apice abrupte rotundata et breviter acuminato-apiculata, admodum trigona, tricostulata, lateribus convexis reticulata et transversim crebre undulato-rugulosa, cellulis extimis verticaliter oblongis sed curvatis, cum stylo-basi 0·85 mm. longa, 0·55 mm. lata; stylo-basis brevissima, minute conica vel ovoidea, vix depressa.

QUEENSLAND.—Gregory North District: Duchess, in rock crevices on low rugged hill, ca. 1,300 feet, May 18th, 1936, *Blake* 11533 (TYPE).

CENTRAL AUSTRALIA.—Hugh River, Macdonnell Ranges, May 4th, 1911, *Hill* 135 (MEL., NSW); Finke River, in 1883, *Kempe* (MEL., BRI.).

? SOUTH AUSTRALIA.—Far North: Cordillo Downs, in watercourse, May, 1924, *Cleland* (BL., CL., BRI.).

The shining white nut with its very abruptly and shortly acuminate-apiculate apex, and in its lower part with straight or inwardly concave edges, are the best distinguishing features of this species. The glabrous glumes and the occasional absence of the hairs from the mouth of the leaf-sheaths are also noteworthy.

The South Australian specimens differ from the other specimens cited in the nearly glabrous slightly coarser culms (up to 0·5 mm. thick), and the distinctly larger glumes and nuts. The former vary from 2·5–3·2 mm. in length, including the very prominent more or less recurved mucro which may be up to 0·5 mm. long, while the nut varies from 0·95 mm. to 1·2 mm. in length, and from 0·6–0·7 mm. in breadth. The material unfortunately is somewhat fragmentary and over-mature, and it is not possible to state whether it represents another closely allied species, or whether it is merely an extreme form of the species here described. It was referred by Black (Trans. Roy. Soc. S. Austr. xlviii., 254: 1924, and in Fl. S. Austr., 677: 1929) to *Bulbostylis capillaris* (L.) C. B. Clarke [*Stenophyllus capillaris* (L.) Britton]. This species has, however, glabrous culms, bearded mouths to the leaf-sheaths, pubescent glumes, brown asymmetrically obovate nuts which are somewhat emarginate and scarcely apiculate at the apex, and the edges near the base convex outwards.

B. capillaris is known from a few widely-scattered localities in Queensland. C. B. Clarke, ex Domin in Biblioth. Bot. xx. Heft 85, 464 (1915) refers the Australian form to the Indian var. *trifida* (Kunth) C. B. Clarke, but to my mind they are much closer and practically indistinguishable from (typical ?) American specimens.

Fuirena nudiflora *S. T. Blake*; species nova (sect. *Hemiscirpus*) affinis *F. pygmaeae* Ridley (speciei africanae) sed aristis glumarum longioribus, nuce albida obscure foveolata nec laevi, stylo-basi minima pyramidata, differt.

Herba graminea, annua, viridis, usque ad 20 cm. alta. *Culmi* solitarii vel fasciculati, erecti, tenues, molles, compressibiles, pluristriati, inter costulas concavi, sub inflorescentia 1–2–nodes. *Foliorum vaginae* breves vel infima internodio longior, nervis pilis albis patulis basi leviter tuberculatis densiuscule praeditae; ligulae apice fimbriolatae, 0·8 mm. longae; laminae lineares, longe sensimque acutatae, planae, 3–7–nerves, leviter carinatae, nervis marginibusque densiuscule albo-pilosae, usque ad 11 cm. longae, usque ad 2·2 mm. latae. *Bracteae* foliis similes, infima inflorescentia brevior longiorve. *Inflorescentia* paniculata; axis communis 2–4–nodis. *Pedunculi* 1–4–ni (plerumque 1–2–ni), usque ad 4 cm. longi, interdum prope apicem divisi. *Spiculae* 3–6–ni dispositae, digitatae vel brevissime spicatae, atrovirides, squarrosae, ovoideae vel oblongae, multiflorae, aristis exclusis 2–3·5 mm. longae et 1·4–1·5 mm. latae. *Glumae* spissae, oblongo-obovatae vel oblongo-ellipticae, obtusae, recurvo-aristatae, tenuiter membranaceae, dorso 3–nerves late obtuseque carinatae, lateribus enerves, omnino pilosae, 0·85–0·95 mm. longae, arista robusta acuta, excurva, setosa, paullo longiore excepta. *Perianthium* nullum. *Stamen* 1; anthera oblonga, obtusa vel minutissime apiculata,

0·2 mm. longa. *Stylus* tenuissimus, 0·4 mm. longus; stigmata 3, stylo subaequilonga. *Nux* albida, obovata, apice fere rotundata, minute apiculata, trigona, anguste tricostulata, lateribus convexa obscure foveolata, 0·45 mm. longa, 0·3 mm. lata, cellulis extimis subquadris obscuris; stylo-basis minima, pyramidata.

QUEENSLAND.—Cook District: Mareeba, April, 1929, *Darnell-Smith* (NSW); near Mareeba, in somewhat open swampy places in *Melaleuca* scrub, ca. 1,400 feet, March 26th, 1938, *Blake* 13433 (TYPE). Burke District: Normanton, *Gulliver* (BRI., MEL.). Leichhardt District: Gainsford, *Bowman* (MEL.). Moreton District: Enoggera Creek, *Bailey*.

This species is readily distinguished from the other Australian species by the small spikelets with relatively long awns to the glumes, the complete absence of a perianth, and the form of the tiny nut.

Fuirena incrassata *S. T. Blake*; species nova (sect. *Eu-fuirena*) affinis *F. ciliari* (L.) Roxb. sed squamis hypogynis interioribus sursum valde incrassatis earum nervis lateralibus evanescentibus et nervo medio obscuro sub apice in aristam longiusculam excurrenti, nuce utrinque longius attenuata, differt.

Herba annua, graminea, viridis, usque ad 45 cm. alta. *Culmi* fasciculati, vix rigidi, stricti vel curvuli, alte striati, glabri, laeves, sub inflorescentia 1–2–nodes. *Foliorum vaginae* internodiis breviores vel multo breviores, striati, sursum pilosae; ligula pilosula, circiter 1 mm. longa; laminae lineari-lanceolatae, acutae vel subobtusae, planae, 7–9–nerves, utrinque nervis marginibusque pilosae, supra etiam inter nervos breviter pubescentes, usque ad 10 (raro 15) cm. longae, usque ad 5·5 mm. latae, infima saepe brevis lataque. *Inflorescentia* paniculata; axis communis 2–4–nodis, internodium infimum plerumque longum cetera saepe brevia. *Bracteae* foliis similes. *Pedunculi* singuli vel bini, compressi, pilosi, infima usque ad 6 cm. longi, superiores multo breviores. *Spiculae* 3–6–ni brevissime spicatae, atrovirides, lanceolatae, acutae, 8–10 mm. longae, 3–3·5 mm. latae (aristis exclusis), multiflorae. *Glumae* oblongo-ellipticae, obtusae, aristatae, tenuiter membranaceae, dorso 3–nervi carinatae, carina sub apice in aristam robustam excurvam pilosam 1·2–1·5 mm. longam excurrente, lateribus enerves, omnino pilosae, marginibus ciliolatae, 2·0–2·5 mm. longae arista exclusa. *Perianthium* biseriatum; setae 3 exteriores filiformes, minute retrorsim scaberulae vel fere laeves, nuce breviores vel eam adaequantes; squamae interiores 3, nucem subadaequantes vel superantes, unguiculatae; earum laminae pentagonae, basi leviter auriculatae fere truncatae, apice fere acutae, pars inferior tenuior manifeste 3–nervis et inter nervos membranacea, pars superior valde incrassata nervis lateralibus evanescentibus mediali sub apice in aristam longam setaceam incurvam excurrenti; unguis ¼ laminae subaequilongus. *Stamina* 3; antherae lineares, minute apiculatae, 0·4–0·5 mm. longae. *Stylus* tenuissimus. *Nux* nitide brunnea quasi-vernicosa, apice breviter acuminata, basi longe abrupteque acuminata, pars media late elliptica, utrinque subpyramidata, acute triquetra, anguste tricostulata, lateribus plana laevisque, cellulis extimis minutis transversim oblongis inconspicuis, 0·75–0·8 mm. longa, 0·65 mm. lata, vel stylo-basi anguste cylindrica inclusa 1·4–1·5 mm. longa.

QUEENSLAND.—Burke District: Croydon, in low-lying, damp, sandy, grassy places, 360 feet, August 5th, 1936, *Blake* 12466 (TYPE); Delta Station, 17° 10′ S., 141° 15′ E., at edge of lagoon, August 14th, 1936, *Blake* 12525. Cook District: Near Staaten River, approximately 16° 30′

S., 142° 5′ E., on a damp, sandy stream bed, August 15th, 1936, *Blake* 12568. North Kennedy District: Townsville, in swamps, March 26th, 1933, *White* 8949; Pentland, on sandy creek bed, ca. 1,300 feet, June 10th, 1934, *Blake* 6032. Mitchell District: Geera, east of Barcaldine, in wet places at edge of bore-drain, 900 feet, December 6th, 1935, *Blake* 10364. Leichhardt District: Nogoa River, near Springsure, in 1890, *Foot* (MEL.). Darling Downs District: Chinchilla, in a watercourse, in wet ground, poor soil, January, 1934, *Beasley* 221; near Tara, on shady, wet, sandy creek bed, ca. 1,000 feet, February 12th, 1938, *Blake* 13270; between Inglewood and Milmerran, January 20th, 1934, *White* 9682; Severn River, *Hartmann* 63 (MEL.).

CENTRAL AUSTRALIA.—Lander's Creek, June 10th, 1911, *Hill* 302 (MEL., NSW.).

Very similar in outward appearance to *F. ciliaris* (L.) Roxb. (*F. glomerata* Lam.), but the strongly thickened, obscurely nerved, long-awned pentagonal laminae of the inner series of the perianth are very different.

Fuirena repanda *S. T. Blake*; species nova (sect. *Eu-fuirena*) affinis *F. incrassatae* S. T. Blake, sed inflorescentia pauciore, spiculis majoribus, petalis lateribus late alatis et apice bilobis minus incrassatis differt.

Herba annua, graminea, viridis, usque ad 30 cm. alta. *Culmi* fasciculati, tenues, alte striati, compressibiles, infra inflorescentiam 0–1–nodes, glabri, laeves. *Foliorum vaginae* crebre striatae, nervis dense pilosae; ligula 0·5–1 mm. longa, ciliolata pilosaque; laminae breves, anguste lanceolatae, acutae, planae, 3–5–nerves, utrinque pilosae, usque ad 25 mm. longae, usque ad 2·2 mm. latae, vel ad mucronem redactae, vel fere nullae. *Inflorescentia* paniculata; axis communis 1–3–nodis, internodium infimum elongatum, usque ad 10 cm. longum, superiora brevia vel brevissima. *Bracteae* foliis majores, infima usque ad 8·5 cm. longa. *Pedunculi* singuli, 1–3–spiculati. *Spiculae* atrovirides, ovato-lanceolatae, 8–15 mm. longae, 4–5 mm. latae (aristis exceptis), multiflorae. *Glumae* ellipticae vel ovato-ellipticae, obtusae, aristatae, tenuiter membranaceae, dorso 3–nerves, nervis sursum coalescentibus sub apice in aristam robustam, acutam, pilosam, leviter excurvam 1·3–2·2 mm. longam excurrentibus, omnino pilosae, lateribus enerves, aristis exclusis 3·2–3·5 mm. longae. *Perianthium* evolutum, biseriatum; series exterior e setis 3 retrorsim scabris nuce multo brevioribus, interior e squamis 3 constructa; squamae longiuscule unguiculatae, earum laminae inferne oblatae, tenues, marginibus incrassatis repandae, 3–nerves, inter nerves membranaceae, pars superior angustior, incrassata, subtriangularis, apice bifida lobis subulatis, 1–nervis nervo sub apice in aristam longiusculam incurvam excurrente. *Stamina* 3; antherae oblongae, minutissime apiculatae, 0·25–0·3 mm. longae. *Stylus* 0·7–0·8 mm. longus; stigmata 3 stylo subaequilonga. *Nux* apice abrupte breviterque acuminata, basin versus subito longeque attenuata, pars media late elliptica, acute triquetra, angulis anguste acutis, lateribus concavis, nitide brunnea, laevis, cellulis extimis minutis transversim oblongis obscurissimis, 0·9–1·0 mm. vel stylo-basi anguste cylindrica scaberula inclusa 2·2–2·5 mm. longa, 0·8–0·9 mm. lata.

QUEENSLAND.—Burke District: Croydon, in low-lying, damp, sandy, grassy places, 360 feet, August 5th, 1936, *Blake* 12467 (TYPE); and in depressions and on stream banks on whitish sand, ca. 350 feet, May 22nd,

1935, *Blake* 9081. Cook District: Near Mareeba, in somewhat open swampy places in *Melaleuca* scrub, ca. 1,400 feet, March 26th, 1938, *Blake* 13434.

This species is characterised by the short leaves, the relatively few but rather large spikelets, and the pentagonal, wavy-margined lamina of the inner hypogynous scales which are thickened, bifid, and awned near the apex.

Schoenus calyptratus *Kükenthal et Blake;* species nova, affinis *S. apogoni* R. et S., *S. foliato* (Hook. f.) S. T. Blake, et *S. philippinensi* (Palla) Kükenthal, sed nuce ob angulos incrassatos late coalescentes apice quasi calyptrata, et plerumque etiam habitu, ab omnibus differt.

Herba perennis, ramosa, repens, caespites humiles densas efformans. *Culmi* ramosi, e nodis radicantes, graciles, dense foliati; culmi floirgeri usque ad 2·5 cm. longi. *Folia* setacea, rigida, stricta vel curvata, involuta, saepissime 4–4·5 cm. longa, plerumque in fasciculis sterilibus aggregata; vaginae purpureae, apertae, glabrae. *Inflorescentia* e fasciculis spicularum 2–3 approximatis composita, 7–11 mm. longa; bracteae foliis similes, inflorescentia longiores vel inferior multo longior, earum vaginae breviter clausae. *Spiculae* in utroque fasciculo 1–2, sessiles vel fere sessiles, ovato-lanceolatae, turgidae, 4 mm. longae, 1·5 mm. latae, uniflorae. *Glumae* ovatae, subacutae, herbaceae, carina viridi leviter incurva scabrae, marginibus purpureo-tinctae, 2 imae vacuae. *Setae hypogynae* 7, filiformes, antrorsim minute scabrae, nuce subaequantes vel longiores. *Stamina* 3; antherae lineares, connectivo mediocriter producto. *Stylus* longus, tenuis; stigmata 3 breviora. *Nux* ovalis vel obovata, stipitata, trigona, marginibus manifeste costulata, apice ob angulos incrassatos late coalescentes quasi calyptrata, breviter apiculata, lateribus alba subnitida punctulata vel fere laevis, cellulis extimis minutis vix conspicuis, 1·8 mm. longa, 0·9 mm. lata.

VICTORIA.—North East: Mt. Buffalo, in morasses ca. 4,500 feet, forming dense dark green mats, January 25th, 1935, *Blake* 7373.

Schoenus elegans *S. T. Blake*; species nova, affinis *S. sculpto* (Nees) Boeck., a quo spiculis tandem patentibus, glumis duabus imis vacuis, nuce breviter acuminata, basi plus minusve rotundata vel subcuneata haud constricta, minus profunde scrobiculata cellulis extimis angustioribus, differt.

Herba annua, caespitosa, gracilis, glabra. *Culmi* fasciculati, stricti, erecti, usque ad 24 cm. alti, compressi, sulcati, molles, glabri laevesque, 0·5–1 mm. lati, infra inflorescentiam saepissime enodes, basi solum foliati. *Folia* cartilaginea, tertium partem culmi raro adaequantia saepe multo breviora, subplana vel ± involuta, enervia, apice subacuta callosa, usque ad 1·2 mm. lata; vaginae purpureae, ore oblique secto imberbes. *Inflorescentia* 4–10 cm. longa, angusta, laxa, e fasciculis ramorum 3–5 distantibus composita; rami interdum divisi, plerumque breves, complanati, marginibus scabro-ciliati. *Bracteae* foliaceae, suberectae, inflorescentia breviores sed internodiis longiores; vaginae breves, purpureo-tinctae, glabrae. *Spiculae* in fasciculo quoque paucae (usque ad 5), brevissime pedicellatae, mox patentes, lineari-lanceolatae, compressae, flavae vel purpureo-tinctae, 7–8 mm. longae, ca. 1·5–1·7 mm. latae, 2–nucigerae. *Glumae* 5–6, membranaceae, lateribus flavescentes vel sanguineo-tinctae, superiores lanceolatae subacutae parce scabrae, inferiores ovatae acutae, 2 imae vacuae. *Setae hypogynae* nullae. *Stamina* 3; antherae lineares, fere muticae, 2·9–3 mm. longae. *Stylus*

longus, tenuis; stigmata 3, multo breviora. *Nux* late elliptica vel admodum obovata, breviter acuminato-apiculata, breviter stipitata, tricostata angulis prominulis, lateribus albidis vel ± nigricantibus manifeste scrobiculata ob cellulas extimas grossas hexagono-oblongas in latere utroque verticaliter 5–6–seriatim dispositas, 1·2–1·3 mm. longa, 0·8–0·9 mm. lata.

WESTERN AUSTRALIA.—South West Division: Bayswater, November, 1902, *Fitzgerald* (TYPE; BRI., NSW).

A somewhat taller plant than *S. sculptus* (Nees) Boeck., and can be distinguished from it by the more or less stellately spreading spikelets and the less prominently acuminate, elliptical not ovate nut. Out of the 25 culms seen, only one bore a node below the inflorescence.

THE VEGETATION OF THE LOWER STANLEY RIVER BASIN.

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(PLATES VI. TO XI.)

(*Read before the Royal Society of Queensland, 25th November, 1940.*)

INTRODUCTION.

This paper was prepared as the result of work done in connection with an expedition to Somerset Dam organised by the Science Students' Association of the University of Queensland in February-March, 1939. It gives an account of the vegetation in an area of about 150 square miles in the lower part of the basin of the Stanley River, one of the chief tributaries of the Brisbane River, between Reedy Creek in the south and Villeneuve and Kilcoy to the north.

TOPOGRAPHY.

The country consists of valleys, gently rolling to hilly country, and some mountainous often very rugged areas, the whole varying in altitude from 200 to a little over 2,000 feet above sea level. The valleys between the hills and ranges vary from small narrow gullies with steeply sloping sides and beds to the broad plain flanking the river and the lower courses of its major tributaries.

CLIMATE.

The average annual rainfall for Kilcoy, at the northern limit of the area, is just about 40 inches; that of Mount Brisbane Station, at the southernmost extremity, is about 32·5 inches (for 30 years prior to 1924; no later figures are available for this station). The wettest month at Kilcoy is February, with an average of 6·2 inches, while at Mount Brisbane it is January, with an average of 4·4 inches. At both places the driest month is August, with an average fall of 1·3 at Kilcoy and 1·25 at Mount Brisbane. Both these stations are in valleys, and it seems quite certain from a study of the area that these figures do not give a satisfactory indication of the rainfall of the area as a whole. There seems little doubt that the rainfall is higher in some places, while it may be lower in others. Mists are known to be common on the higher hills and mountains. No data are available as to temperature, humidity, or winds.

GEOLOGY AND SOILS.

The geology of the area is complicated, and is not yet thoroughly understood. No attempt will be made to discuss it here, but reference is made to the work of Hill (1930) and C. W. Ball (1940), where also previous work is discussed. Geological work was carried out concurrently with the botanical work in 1939, and I wish to thank Dr. D. Hill, Mr. E. V. Robinson, and Mr. F. Chippendale for the use of unpublished data in drawing up the few remarks that follow.

There is a wide variety of rock-types, including acid and basic igneous rocks of varied nature, schists, shales, grits, conglomerates, sandstones, and sandy limestones. The igneous rocks are found usually

on the higher ground and the other rocks at the lower levels, though these are frequently seen intruded by the former.

The soils, too, are rather varied, with a tendency for red-brown earths to be formed over the less acid igneous rocks and sometimes over andesite, and podsols over the more acid rocks. Several kinds of podsol occur. Brown forest soils are found in places, sometimes showing an approach to chernozems in depressions and shallow gullies. The plains flanking the river and its major tributaries carry alluvial soils up to 20 feet in depth. They are usually sandy and more or less podsolised, though river gravels occur in places.

VEGETATION.

There has been no previous attempt to describe the vegetation of this area. The following account is based upon a number of traverses and a closer study of particular areas, but no attempt was made to estimate species-frequency. Owing to the unusually dry seasonal conditions, it is probable that the lists of herbaceous species in the Open Forest communities are incomplete, as some species may not have been recognisable. Also, owing to the intrinsic difficulties in studying such communities, the list of species given for some communities of the Closed Forest must be incomplete.

Apart from weeds of cultivation, &c., which were not specially studied, the vegetation may be grouped into four main types:—

I.—Open Forest.

II.—Closed Forest.

III.—Fringing Forest and other fringing communities.

IV.—Aquatic Vegetation.

I. OPEN FOREST.

Open Forest occupied or used to occupy by far the greatest area, occurring in almost all kinds of habitats except stream banks and the sheltered gullies and slopes of the higher mountains. The chief trees forming the forest are species of *Eucalyptus, Angophora*, and *Tristania*, with *Casuarina torulosa* and *Xanthorrhoea arborea*. There is relatively little undergrowth in most communities, but as the result of human interference patches or masses of *Lantana camara* (lantana) are common in places. The trees are often straight and well-formed, attain a considerable height (70 feet or so), and in some communities a practically closed canopy is produced. Since settlement many trees have been destroyed. Some have been removed for timber purposes, others have been merely killed by ringbarking for the purpose of improving the natural pasture, and left standing. As a result of this the original forest has in many places been thinned to parkland or even induced grassland. A few introduced herbaceous plants, chiefly the grasses *Paspalum dilatatum* (paspalum), *Chloris gayana* (Rhodes grass), and *Digitaria didactyla* (blue couch), have become common enough to modify the natural herbaceous communities, and these have been further modified by cattle-grazing, and possibly also by the periodic fires. It has not been possible to trace all the changes which have occurred since the beginning of settlement by white man, but it seems fairly certain that *Themeda australis* (kangaroo grass) was much more abundant than it is to-day.

The chief major communities are:—

1. Mixed Eucalyptus Forest (Fig. 1.).—The trees are *E. racemosa* (narrow-leaved ironbark), *E. decepta* (grey ironbark), *E. melanophloia* (silver-leaved ironbark), *E. tessellaris* (Moreton Bay ash), *E. gummifera* (bloodwood), and occasionally the small trees *Alphitonia excelsa* (red ash) and *Exocarpus cupressiformis* (native cherry—a root parasite). This is the most widely spread forest type and occurs chiefly on podsolised soils on slopes of medium steepness and covering the lower ridges, but it is also one of the types that have suffered most from settlement. Minor variations in habitat seem to be the cause of the observed fact that sometimes one or more of the tree species may be absent and one or other may assume local dominance. The bloodwood seems to have been largely removed (for timber) and very few trees are to be seen now. It may never have been very common. The herbaceous cover is possibly denser than in the virgin forest and *Themeda* has almost disappeared. The chief plants are *Bothriochloa decipiens* (pitted blue grass), *Aristida ramosa* (a spear grass), *Eragrostis leptostachya* (meadow love grass), *Digitaria didactyla* (blue couch), *Fimbristylis* sp., *Cyperus gracilis, Desmodium varians, Glycine tabacina, Zornia diphylla, Glossogyne tenuifolia, Helichrysum apiculatum, Verbena venosa,* and the annuals *Erigeron crispus* and *Erythraea australis. Lantana* is occasional. The remaining plants, all herbaceous, are—firstly, the grasses: *Aristida acuta, A. gracilipes, A. glumaris, Bothriochloa intermedia, Capillipedium parviflorum, Cenchrus australis, Chloris divaricata, Ch. truncata, Cymbopogon refractus, Dichanthium sericeum, D. affine, Digitaria orbata?, Eragrostis Brownii, E. elongata, E. parviflora, Eremochloa bimaculata, Eriochloa procera, Enneapogon pallidus, Heteropogon contortus, Hyparrhenia filipendula, Leptochloa* sp., *Panicum effusum, Paspalidium gracile, Poa australis, Sehima nervosum, Sorghum leiocladum, Sporobolus elongatus, Themeda australis*; and in addition *Alternanthera nana, Arthropodium paniculatum, Brunella vulgaris, Cassia mimosoides, Cheilanthes Sieberi, Crotolaria linifolia, Cyperus fulvus, Erechthites arguta, Erigeron canadensis, Gnaphalium japonicum, Justicia* sp. aff. *J. procumbens, Laxmannia gracilis, Malvastrum coromandelinum, M. spicatum, Notholaena distans, Portulaca oleracea, Rhynchosia minima, Rumex Brownii, Sida rhombifolia,* and *Wahlenbergia multicaulis.*

2. *Eucalyptus umbellata–Angophora subvelutina* (blue gum–apple) Forest.—This type of community occupies the alluvial flats and ascends the lower courses of some of the gullies, mingling to some extent with the previous type. Modifications approaching the mixed Eucalyptus Forest are to be seen on patches of heavy soil approaching the brown forest soils. The gum is usually taller and stouter than the members of the mixed forest, and is frequently parasitised by *Loranthus pendulus,* a mistletoe with long slender drooping branches which also parasitises other species. The apple is usually more or less irregular in form and not so tall as the gum. *Tristania suaveolens* (swamp mahogany) is at times common as a tall straight tree near depressions or small gullies. This forest has also been extensively cleared, and the herbaceous cover tends to be dominated by *Paspalum dilatatum.* As a result of grazing this grass usually forms a short, dense sward through which other members of the community push their way. These are chiefly *Bothriochloa decipiens* (often as co-dominant), *Aristida ramosa, Cyperus gracilis, Desmodium varians, Glycine tabacina,* and *Glossogyne tenuifolia.* In damp depressions tufts of *Juncus polyanthemus* are to be found, and

in still damper places there is a tendency for *Pennisetum alopecuroides* to co-dominate with *Paspalum* to the exclusion of everything else.

The other species of the blue gum–apple forest are *Cyperus fulvus, Dichanthium affine, Eragrostis leptostachya, E. sororia, Erigeron canadensis, E. crispus, Fimbristylis* sp. aff. *F. dichotoma, Kyllinga triceps, Lagenophora bellioides, Phyllanthus minutiflorus, Psoralea tenax, Richardsonia brasiliensis, Rumex Brownii, Sporobolus elongatus, Verbena venosa,* and *Wahlenbergia multicaulis.*

3. *Eucalyptus hemiphloia* (gum-topped box) Forest (Fig. 2).—This occupies fairly large areas of flat or gently sloping country, the soil being a podsol. Often the only tree present is *Eucalyptus hemiphloia,* the individuals of which are straight and often tall and closely spaced. An ironbark (*E. decepta* ?) and a grey gum (*E. propinqua* ?) are occasional. Shrubs are restricted to a few low almost bushy plants of *Eustrephus latifolius* var. *angustifolius* and *Jasminum suavissimum* (both usually slender lianas), an occasional *Solanum* sp., and the prostrate *Myoporum debile,* while the herbaceous layer is sparse and consists chiefly of rather scattered plants of *Aristida vagans, A. ramosa, Eremochloa bimaculata, Eragrostis leptostachya, Panicum fulgidum, Microlaena stipoides, Cyperus gracilis, Desmodium rhytidophyllum,* and *Sida subspicata.* There also occur occasional plants of *Bothriochloa decipiens, Glossogyne tenuifolia,* and *Helichrysum apiculatum.*

4. *Angophora lanceolata* (rusty gum or sugar gum) Forest (Fig. 3).—The communities of this are rather small in area and occupy flat expanses, usually the crests of low undulations, with a more or less strongly gravelly soil. The trees are fairly dense and usually straight and rather well formed with a relatively long and narrow dense crown. This is unusual, as the species is so often an irregular tree. Occasionally *Eucalyptus decepta* and *E. gummifera* are to be seen. Shrubs are absent, and the herbaceous layer is rather sparse and consists chiefly of *Aristida vagans, A. glumaris, Eragrostis sororia, E. leptostachya, Cyperus gracilis, Zornia diphylla,* and *Hardenbergia bimaculata,* though in one or other of the communities there also occur *Brachiaria miliiformis, Chloris ventricosa, Crotolaria linifolia, Digitaria didactyla, Glycine clandestina,* and *Paspalidium distans.* These communities are usually surrounded by and merge into *Eucalyptus hemiphloia* forest with a more or less pronounced ecotone.

5. *Eucalyptus maculata–E. racemosa* (spotted gum–ironbark) Forest (cf. Fig. 4).—This occupies the upper slopes and crests of ridges or low hills on podsolised soils with free quartz pebbles on the surface. There is practically no underwood, and the chief herbaceous plants are somewhat scattered. These are *Themeda australis, Capillipedium parviflorum* (scented golden-beard), *Heteropogon contortus* (bunch spear grass or black spear grass), *Aristida ramosa, Eragrostis Brownii, E. elongata, E. leptostachya, E. sororia, Cyperus gracilis, C. fulvus, Glycine clandestina,* and *Crotolaria linifolia* (a rattle-pod), but there are also present *Bothriochloa decipiens* (rare), *Chloris divaricata, Digitaria divaricatissima* (rare), *Desmodium rhytidophyllum, Erigeron canadensis, E. crispus, Erythraea australis, Helichrysum apiculatum, Panicum effusum, Phyllanthus* sp., *Sida corrugata, S. rhombifolia,* and *Verbena venosa.* Where the ironbark tends to drop out of the community, *Aristida* tends to dominate the ground flora, and where the spotted gum drops out, the community merges into the mixed Eucalyptus forest.

6. *Eucalyptus racemosa–Casuarina torulosa–Xanthorrhoea arborea* (ironbark–oak–grass-tree) Forest (Fig. 5).—This forest is developed on the upper part of the higher hills on generally steeply sloping ground, and is poor in species. The eucalypt averages 50–70 feet in height, the *Casuarina* 20–25 feet, and the *Xanthorrhoea* 10–15 feet. The only other woody plant normally present is an occasional low shrub of *Grewia latifolia*. Completely covering the ground is a dense growth of *Themeda australis* and *Poa australis* with some *Sorghum leiocladum, Cymbopogon refractus* and *Erechthites arguta,* and occasionally *Fimbristylis monostachya, Glycine clandestina,* and *Lespedeza sericea.* At its lower edge this forest passes into mixed Eucalyptus forest, *Casuarina* being the first to drop out. In some places however, as for instance on Little Mount Brisbane, it impinges directly on Closed Forest, often without any ecotone.

7. *Eucalyptus carnea–E. punctata* (stringy-bark–grey gum) Forest (Fig. 6).—This forest was only seen on the range to the west of the township of Somerset Dam at an altitude of 1,400–2,000 feet on a light coloured, light-textured, rather shallow, almost skeletal soil developed on alaskite, boulders of which are scattered here and there over the surface. The dominant trees are well-formed, rather massive, and the tallest eucalypts seen in the area. They form a relatively dense canopy. *Casuarina torulosa* is scattered through the community as a discontinuous under-storey, while the grey gum drops out in places. There is a well-developed underwood, though nowhere really dense, of the spiny-leaved shrubs *Acrotriche aggregata* and *Oxylobium trilobatum,* together with *Monotoca scoparia, Persoonia Mitchelli, Indigofera australis, Tephrosia purpurea, Hovea acutifolia, Macrozamia spiralis* (in places,) and young *Tristania conferta* and *Acacia Maidenii?* The ground flora is dense and rich, composed of many individuals belonging to many families, of which the commonest and tallest (2–3 feet) are the grasses *Themeda australis, Poa australis, Cymbopogon refractus, Digitaria* sp. aff. *D. recta,* and the smaller *Aristida vagans* (rare), besides the sedge *Lepidosperma laterale.* Other common herbs are *Didiscus incisus, Goodenia rotundifolia, Desmodium rhytidophyllum, D. brachypodum, Erechthites arguta, Helichrysum bracteatum, Lomandra longifolia, L. multiflora, Dianella caerulea, Plectranthus australis, Spermacoce* sp., and *Poranthera microphylla.* Herbaceous twiners are the legumes *Glycine clandestina, Hardenbergia bimaculata,* and *Kennedya rubicunda,* and the woody twiners *Cissus opaca* and *Eustrephus latifolius* var. *angustifolius* are also present. Less common herbaceous plants are *Danthonia semiannularis? Desmodium varians, Echinopogon ovatus, Entolasia stricta, Glossogyne tenuifolia, Hybanthus enneaspermus, Imperata cylindrica* var. *Koenigii* (blady grass), *Lagenophora stipitata, Oxalis* sp. and *Vernonia cinerea.* At its lowermost edge this forest frequently borders upon closed forest with a definite ecotone between.

8. *Eucalyptus punctata–E. paniculata?–Tristania conferta Forest.* This is often found on the fringe of Closed Forest, and is rather in the nature of an ecotone community. Sometimes the *Tristania* (scrub box) occurs alone, sometimes it is absent, but when present the canopy is usually closed or nearly so. All variations in composition may occur in sheltered places on hillside gullies, whether Closed Forest be present or not. Shrubs characteristic of the Ecotone (see below) may be present. The chief herbaceous plants are *Themeda australis, Poa australis, Microlaena stipoides, Gymnostachys anceps, Carex declinata,* &c.

9. On very rocky places on hillsides are to be found communities of chiefly herbaceous plants which are more or less independent of the general forest type. The ferns *Drynaria rigidula* and *Notholaena distans* and the labiate *Plectranthus australis* are specially characteristic, and if there are definite rock faces or ledges the orchid *Dendrobium Kingianum* is usually to be found. Other ferns and orchids and a few grasses are also fairly common. These are *Adiantum aethiopicum*, *A. hispidulum*, *Davallia pyxidata*, *Doodia heterophylla*, *Pteris tremula*, *Pyrrhosia confluens* and *P. rupestris*, the last two long-creeping; *Bulbophyllum* sp., *Dendrobium*, *linguiforme* (creeping), *Liparis reflexa*, and *Sarcochilus falcatus*; *Entolasia stricta*, *Imperata cylindrica* var. *Koenigii*, *Leptochloa* sp., *Paspalidium gracile*, and *Tripogon loliiformis*. Other noteworthy plants are *Gymnostachys anceps*, *Lomandra multiflora*, the wiry twiners *Eustrephus latifolius* var. *angustifolius*, *Hardenbergia bimaculata*, *Smilax australis*; and the shrubs *Brachychiton Bidwillii*, *Indigofera australis*, *Lantana camara*, *Phyllanthus similis*, and *Trochocarpa laurina* (this last sometimes a small tree). Some of these species have been mentioned as occurring in communities already dealt with, others are mentioned below in dealing with the origin of Closed Forests.

II. CLOSED FORESTS.

The Closed Forests vary considerably in extent, and are popularly known as "scrubs." Broadly speaking, two main types may be distinguished:—

1.—Pine "Scrubs."

2.—Isolated "Scrubs."

1. The Pine Scrubs occupy the larger continuous areas and are invariably found on mountain sides, often in gullies or on low saddles or other more or less sheltered habitats. The ground is almost invariably steep, often very steep, and usually rocky. The woody plants are numerous in species with dense or fairly dense canopies, and are so closely spaced that relatively little direct sunlight ever reaches the ground. Lianas are common, epiphytes are not very common, and there are very few herbs on the forest floor. The forests approach true Rain Forest in many characters—and indeed there are a few small areas on the banks of some of the creeks which might with justice be called Rain Forest—but on the whole they differ in the paucity of epiphytes, in the absence of *Calamus* (lawyer-vine) among the lianas, in the poor development of buttresses, and in the relative frequency of deciduous or partially deciduous trees. In some communities the hoop pine (*Araucaria Cunninghamii*) is by far the tallest tree and completely dominates the forest, and it is these communities that are least like Rain Forest (Fig. 7). The other trees are relatively small and often shrubby. There are four distinct storeys. The tallest is a discontinuous one, composed of the *Araucaria* alone, the next is about 30 feet high, composed of several species, including *Laportea photiniphylla*, *Bridelia faginea*, *Ficus eugenioides*, &c., the third is composed of shrubs 8–15 feet high, of which *Alchornea aquifolium* is very characteristic, while the lowermost consists of a sparse layer of herbaceous or slightly woody plants, of which *Nyssanthes diffusa* is probably the commonest. Owing to the difficulty of thoroughly studying these forests, due partly to the frequent extreme ruggedness of the habitat and the difficulty of penetration

further increased in places by dense masses of *Lantana*, and partly to the difficulty of identifying the numerous species, it is only possible to sketch the salient features of the areas visited. A complete list of species certainly identified is given below. The trees most frequently associated with the pine (second storey) are *Acacia aulacocarpa*, *Alectryon connatus*, *A. tomentosus*, *Atalaya hemiglauca*, *Bridelia faginea*, *Microcitrus australis*, *Erythrina vespertilio*, *Ficus eugenioides*, *Flindersia australis*, *Laportea photiniphylla*, *Maba fasciculosa*, *Mallotus philippinensis*, and *Rhodosphaera rhodanthema*. The more frequent shrubs of the third storey are *Acalypha nemorum*, *Alchornea aquifolium*, *Canthium lucidum*, *Capparis nobilis*, *Citriobatus pauciflorus*, and *Wilkiea macrophylla*. The commoner herbs are *Aneilema biflorum*, *Oplismenus imbecillis*, *Pellaea paradoxa*, *Pyrrhosia rupestris* (creeping on rocks or trees), *Rivina laevis* (introduced), and the somewhat shrubby *Nyssanthes diffusa*. The chief epiphytes are *Dendrobium speciosum*, *D. teretifolium*, and *Platycerium grande*. Among the frequent lianas may be mentioned *Cissus antarctica*, *Jasminum didymum*, *Lonchocarpus Blackii*, *Pandorea pandorana*, *Rhipogonum* sp., and *Tetrastigma nitens*, the last-mentioned with long, very fine aerial roots. In many communities the introduced *Lantana camara* has gained entry along tracks and clearings following the removal of pine for milling purposes, and in places forms almost impenetrable masses. The shrubby grass *Ancistrachne uncinulata* is to be seen in places, while some areas are characterised by the predominance of tall straight trees of *Syncarpia subargentea*, very prominent on account of its smooth pink bark and prominent buttresses. In such communities and in others where the pine tends to be or is almost entirely replaced by tall trees belonging to such species as *Euroschinus falcatus*, *Harpullia pendula*, *Flindersia australis*, *Hernandia bivalvis*, &c., a very close approach to true Rain Forest is attained (cf. Fig. 8). The shrubby layer is less dense and more varied than in typical Pine Scrubs, and such communities should probably be given a distinctive name, but they have not yet been sufficiently studied.

There is usually a well-marked ecotone between these Closed Forests and the surrounding Open Forest, frequently *Eucalyptus punctata–E. paniculata?–Tristania conferta* forest. Some trees, such as *Mallotus philippinensis*, simply pass out from the Closed Forest, but there are a number of species which are restricted or nearly restricted to these ecotones. These include *Acacia decurrens*, *Duboisia myoporoides*, and *Hibiscus heterophyllus* (small trees or tall single-stemmed shrubs), *Cassia retusa*, *Abutilon acutatum*, *Brachychiton Bidwillii*, *Myrtus rhytisperma*, and *Plumbago zeylanicum* (smaller shrubs), *Stipa ramosissima* (a shrubby grass up to 8 feet high), *Macrozamia spiralis* (stemless), *Smilax australis* (a liana), and the herbs *Aristida gracilipes*, *Carex declinata*, *Cyperus enervis*, *C. laevis*, *Chloris unispicea*, *Doodia aspera*, *Gymnostachys anceps*, and *Leptochloa* sp.

Occasionally the Closed Forest shows an advance into the Open Forest, old trees of the latter occurring within the fringe of the former. The advance is initiated by the ecotone species, under whose canopy Closed Forest species can and do multiply, but prevent the growth of the Eucalypts. But at times a complete equilibrium is attained, sometimes over a considerable area, in which seedling and adult trees of both formations are associated. This is the Hoop Pine–Ironbark Forest of Swayne (1928), which is common in the Brisbane Valley, but is very rare in the area discussed in this paper. In other cases there is no perceptible ecotone, so that there is a sharp line of demarcation except

for the fact that *Abutilon acutatum, Aristida gracilipes, Chloris unispicea,* &c., grow round the edge under the Eucalypts.

2. Of great ecological interest are the numerous small isolated "scrubs" scattered about the hillsides, usually on particularly rocky places (Figs. 9, 10, 11). These vary from a few yards up to 100 yards in diameter, and there is usually a complete absence of ecotone, so that from a distance these scrubs are visible as dark-green dots and patches set amongst the grey-green of the Open Forest of the hillsides. Hoop pine is usually absent from the smaller of these communities and certain grasses are characteristic. *Ancistrachne uncinulata* is by far the commonest and it occurs also in the Pine Forests, *Stipa ramosissima* is not uncommon, and *Leptochloa* sp. is universal. The trees and shrubs are all those of the Pine Forest, but as one might expect from the size of the communities, they are not so varied in nature. Lianas are relatively numerous, but epiphytes (other than mosses and lichens) are absent. *Brachychiton Bidwillii* is a common plant at the edges.

The following is a complete list of the twenty-two species found in the community shown in Figs. 9–10: *Alectryon tomentosus, Flindersia australis, Laportea photiniphylla, Mallotus philippinensis,* and *Melia dubia* (trees); *Acalypha capillipes, Alchornea aquifolium, Capparis nobilis, Ellatostachys xylocarpa, Myrsine variabilis, Turraea pubescens* (shrubs) and *Ancistrachne uncinulata* (somewhat shrubby); *Cissus opaca, Hoya australis, Jasminum didymum,* and *Malaisia tortuosa* (lianas); and *Adiantum aethiopicum, Brachiaria foliosa, Cyperus gracilis, Eranthemum variabile, Leptochloa* sp., and *Scleria Brownii* (herbs).

These communities appear to be of some age, but in one case a young community was found on the bank of a small gully (Fig. 11) which consisted of one young plant of *Euroschinus falcatus* about 20 feet high, six young trees of *Mallotus philippinensis* 12–15 feet high and a few smaller ones, a shrub of *Breynia oblongifolia* at the edge, and under the canopy occurred *Adiantum aethiopicum, Eustrephus latifolius* var. *angustifolius,* and a young plant of the liana *Pandorea pandorana.*

There is evidence to indicate that at least some of the isolated scrubs may have originated from the communities of *Drynaria rigidula* on rocky slopes. This fern forms dense patches, accumulates humus at the base of the barren leaves, and throws considerable shade on the substratum. Certain ecotone species appear then to develop among the fern, of which *Gymnostachys anceps, Smilax australis,* and *Lantana camara* are common. *Trochocarpa laurina* sometimes occurs, with or without the fern, and other tree species have been found associated with these patches. In one instance, the appearance of a fig (*Ficus eugenioides*), probably from seed dropped by a bird, has initiated a Closed Forest succession under its canopy. Further, it seems likely that following man's interference, *Lantana* has helped considerably in the advancement of Closed Forest by the amount of shade formed at the margins of the latter. It is possible also that the rocky areas offer protection from fire to any Closed Forest seedlings that may chance to germinate there, a protection which is not required by the seedlings of Open Forest trees.

When Closed Forest is destroyed the area is soon occupied by a dense growth of *Lantana,* through which such pioneer species as *Codonocarpus australis, Pipturus argenteus, Capparis nobilis, Alyxia ruscifolia,* &c., push their way.

III. FRINGING COMMUNITIES.

These communities are developed along the banks of streams, rarely extending any distance beyond the margins. The sandspits and shingle banks of the river are themselves colonised by certain species, often annuals, which may be removed by each flood and do not form a stable vegetation. The species chiefly concerned are *Cyperus polystachyos*, *Fimbristylis bisumbellata*, *Polygonum decipiens*, *P. lapathifolium*, and *P. orientale*. Less frequent are *C. exaltatus*, *C. difformis*, *C. trinervis*, and *F. aestivalis*. Distinctive herbaceous communities of a more permanent nature are to be found fringing the banks of small sluggish streams, and similar communities also occur occasionally along the banks of the river. The characteristic plants are the grasses *Pennisetum alopecuroides* and *Paspalum distichum*, and the sedges *Cyperus exaltatus*, *C. globosus*, and in some places *C. eleusinoides* and *C. vaginatus*. Extending into the water itself are *Typha angustifolia* (bullrush) and *Scirpus lacustris*.

A Fringing Forest of some kind is usually to be found along the watercourses. In its most primitive form this Fringing Forest consists of a few scattered trees of *Tristania suaveolens* on the banks of some of the gullies which contain water only at infrequent intervals. Larger watercourses have usually (in this area) a sandy to rocky bed and retain moisture much longer. Along such are developed a more or less closed community of rather tall trees of *Casuarina Cunninghamiana* (river oak) and *Melaleuca bracteata* (Fig. 12), with a more or less closed ground cover of such shade-loving plants as *Agrostis avenacea*, *Cyperus enervis*, *Microlaena stipoides*, and *Paspalidium distans*, with *Cyperus trinervis* at the edge of the shingle. Where there is permanent water, there is a tendency for the *Melaleuca* to be replaced by *Callistemon viminalis* (red tea-tree, red bottle-brush) though the latter may extend further upstream from permanent water. Along the larger streams, such as the Stanley River and Kilcoy Creek, the characteristic tree is the river myrtle, *Eugenia Ventenatii*, often with *Castanospermum australe* (Moreton Bay chestnut, Black bean) associated. Both *Casuarina* and *Callistemon* may be present. The ground flora consists of clumps of *Lomandra longifolia* with *Cyperus gracilis*, *C. enervis*, *C. mirus*, *C. trinervis*, *Microlaena stipoides*, *Paspalidium distans*, and more or less *Digitaria didactyla*.

Along many of the tributary creeks a Closed Forest approaching Rain Forest in character is to be found in the narrow valleys near the sources, and *Melia dubia* sometimes with *Laportea* spp. may extend downstream into the *Casuarina–Melaleuca* forest.

IV. AQUATIC VEGETATION.

This was not studied in detail. Apart from numerous *Algae* the following submerged plants are common in the river:—*Ceratophyllum demersum*, *Hydrilla verticillata*, *Potamogeton crispus*, and *Vallisneria spiralis*; chiefly submerged are *P. javanicus* and *Myriophyllum verrucosum* (flowering parts emerged); *Ottelia ovalifolia* and *Triglochin procera* are partly floating, while *Limnanthemum indicum* has all its leaves floating. In the small streams *Triglochin* and *Ottelia* are the more common Angiosperms, while *Characeae* also occur. *Typha angustifolia* and *Scirpus lacustris*, which are submerged at base only, are also common.

LIFE-FORMS AND DISTRIBUTION OF THE SPECIES.

Except for a few weeds of cultivation or roadsides and a few roadside waifs all the species recognised in the area are listed in the following tables. For reference the life-forms are given according to the system of Raunkiaer as given by Wood (1937) and discussed by du Rietz (1931). But a caution must be given against the use of the data in statistical analyses*. As pointed out at the beginning of the paper, the lists almost certainly are incomplete. The area described is fairly representative of a considerable part of South-East Queensland, yet a few species which are abundant in neighbouring districts were not recorded from this area. (*Siegesbeckia orientalis*, a common species of the Closed Forest ecotone, is one of these). It is sometimes difficult to assign plants to a definite life-form, and such compound symbols as H-Ch have been employed in an effort to overcome this. In the case of the species of the Closed Forest, the broad divisions are elaborated by the addition of brief notes, as so many of the species have not been mentioned in the descriptions of the communities. In Table II. are listed the species found in the other communities discussed. Almost all these have been mentioned in the earlier part of the paper, and are brought together here to show the distribution of the different species. But some of these are abundant in some communities and very rare in others.

The families of Angiosperms are arranged according to the system of Hutchinson (1926, 1934). The nomenclature of the Eucalypts follows that of Blakely (1934), the trees of the Closed Forests that of Francis (1929), that of the *Cyperaceae* and *Gramineae* follows recent revisional work by various workers, including the present author, while the remainder is very much that of Bailey (1913), except for a few emendations by Domin (1915, 1921-29), where such could be checked. The nomenclature of the ferns follows that of Miss D. A. Goy in the Queensland Herbarium, and is substantially that of Christensen (1906, 1913-1916).

For convenience, an abbreviated table of Raunkiaer's Life Forms adapted from Wood (1937) is given herewith.

a. *Mega-* and *Mesophanaerophytes* (MM); woody plants more than 8 metres high (Megaphanaerophytes are more than 30 metres high and are not specially indicated).
b. *Microphanaerophytes* (M.); woody plants from 2 to 8 metres high.
c. *Nanophanaerophytes* (N.); woody plants from 25 centimetres to 2 metres high.
d. *Chamaephytes* (Ch.); chiefly undershrubs up to 25 centimetres high.
e. *Hemicryptophytes* (H.); plants with perennating buds buried in the surface layers of the soil, as for example, most grasses.
f. *Geophytes* (G); plants with perennating buds buried deep in the soil, such as bulbous and rhizomatous plants.
g. *Helophytes* (HH.); plants growing in water.
h. *Therophytes* (Th.); annual plants.
i. *Epiphytes* (E.); plants growing on other plants, or on rocks.
j. *Succulents* (S.).

* This warning is given in an effort to prevent such misleading statements as that given by Wood in the work quoted above, where on p. 22 he gives Life Spectra of "Typical Australian Plant Communities." For "Tropical Forest, Queensland," he gives 4 per cent. Therophytes and no Epiphytes. Rain forest is evidently meant, particularly as he states there are 18 lianas present, but epiphytes are a *sine qua non* of such communities, and further no living Queensland botanist has ever noticed a therophyte in a rain forest, unless perhaps in clearings or on roadsides or very broad tracks. This, of course, does not mean that such a thing is an impossibility, but it is scarcely characteristic of such communities. Wood, however, cites no authority for his figures.

TABLE I.

THE SPECIES OF THE CLOSED FOREST COMMUNITIES AND ECOTONES

Species.	Life-form.	Remarks.
PTERIDOPHYTA.		
Adiantum aethiopicum L.	H.	Loosely tufted
A. hispidulum Sw. ..	H.	Loosely tufted
Asplenium adiantoides (L.) C. Christens.	E.	On *Platycerium*
Doodia aspera R.Br. ..	H-Ch.	Tufted
Dryopteris queenslandica Domin	H-Ch.	Tufted
Pellœa nana (R.Br.) ..	H-Ch.	Forming masses on rocks
P. paradoxa (R.Br.) Hook.	H.	Not tufted
Platycerium grande J. Sm...	E.	
P. bifurcatum (Cav.) C. Christens.	E.	
Pyrrhosia confluens (R.Br.) Ching	E.	Creeping liana
P. rupestris (R.Br.) Ching..	E.	Creeping liana
GYMNOSPERMAE.		
PINACEAE.		
Araucaria Cunninghamii Ait.	MM.	Often very tall
CYCADACEAE.		
Macrozamia spiralis (R.Br.) Miq.	Ch.	Large Rosette; Ecotone
ANGIOSPERMAE.		
ANONACEAE.		
Melodorum Leichhardtii (F. Muell.) Benth.	M-MM.	Liana
MONIMIACEAE.		
Wilkiea macrophylla (A. Cunn.) A.DC.	N-M	
HERNANDIACEAE.		
Hernandia bivalvis Benth.	MM.	
MENISPERMACEAE.		
Legnephora Moorei (F. Muell.) Benth.	MM.	Liana
CAPPARIDACEAE.		
Capparis nobilis (Endl.) F. Muell.	M.	More or less prickly
C. sarmentosa A. Cunn. ex Benth.	M.	Creeping prickly liana
PHYTOLACCACEAE.		
Codonocarpus australis A. Cunn. ex Moq.	M.	
Rivina laevis L.	Ch.	Introduced, but common
CHENOPODIACEAE.		
Chenopodium triangulare R.Br.	Ch.	Rare
Rhagodia hastata R.Br. ..	Ch.	Rare
AMARANTACEAE.		
Nyssanthes diffusa R.Br. ..	Ch-N.	Divaricating half-shrub
THYMELEACEAE.		
Pimelea altior F. Muell. ..	N.	In ecotone
PROTEACEAE.		
Grevillea robusta A. Cunn...	MM.	
PITTOSPORACEAE.		
Citriobatus pauciflorus A. Cunn. ex Benth.	N-M.	Prickly, with small leaves
Hymenosporum flavum (Hook.) F. Muell.	M.	Deciduous
FLACOURTIACEAE.		
Scolopia Brownii F. Muell.	M.	
PASSIFLORACEAE.		
Passiflora alba Link & Otto	Ch.	Rather tall liana; introduced, rare
MYRTACEAE.		
Backhousia myrtifolia Hook. & Harv.	M.	
Myrtus acmenioides F. Muell.	M.	Stems crooked, bark thin, deciduous
M. rhytisperma F. Muell. ..	N.	
Syncarpia subargentea C. T. White	MM.	Buttressed; bark deciduous

Species.	Life-form.	Remarks.
STERCULIACEAE.		
Brachychiton acerifolius (A. Cunn.) F. Muell.	M-MM.	Leaves deciduous
B. Bidwillii Hook. ..	N.	Leaves deciduous
MALVACEAE.		
Abutilon acutatum C. T. White MSS.	N.	Soft-wooded
Hibiscus heterophyllus Vent.	M.	Soft-wooded
EUPHORBIACEAE.		
Acalypha capillipes F. Muell. ex Muell. Arg.	N.	
A. nemorum F. Muell. ex Muell. Arg.	N.	
Alchornea aquifolia (J. Sm.) Domin	N.	Very common
Breynia oblongifolia Muell. Arg.	N.	
Bridelia faginea (Baill.) F. Muell. ex Benth.	M.	
Claoxylon sp.	M.	
Cleistanthus Cunninghamii (Muell. Arg.) Muell. Arg.	M.	
Croton insularis Baill. ..	M.	
Hemicyclia australasica Muell. Arg.	M.	
Mallotus claoxyloides (F. Muell.) Muell. Arg.	N.	
M. philippinensis (Lam.) Muell. Arg.	M.	
Tragia novae-hollandiae Muell. Arg.	M.	Very slender liana, with stinging hairs
CAESALPINIACEAE.		
Cassia retusa Soland. ex Vog.	N.	In ecotone
MIMOSACEAE.		
Acacia aulacocarpa A. Cunn. ex Benth.	M.	
A. decurrens (Wendl.) Willd. (sens. lat.)	M.	In ecotone
A. Maidenii F. Muell. ..	M.	In ecotone
PAPILIONACEAE.		
Erythrina vespertilio Benth.	M.	Leaves deciduous; trunk slightly prickly
Castanospermum australe A. Cunn. & Fraser	MM.	Chiefly on stream banks
Lonchocarpus Blackii (F. Muell.) Benth.	MM.	Liana
ULMACEAE.		
Aphananthe philippinensis Planch.	M.	
MORACEAE.		
Cudrania javanensis Trecul	M.	Prickly liana
Ficus eugenioides (Miq.) Miq.	M-MM.	Partly deciduous
F. stenocarpa F. Muell. ex Benth.	M.	Partly deciduous
F. Watkinsiana F. M. Bail.	MM.	
Malaisia tortuosa Blanco ..	MM.	Liana
Pseudomorus Brunoniana Bur.	M.	
URTICACEAE.		
Laportea gigas Wedd. ..	M.	With stinging hairs
L. photiniphylla (Kunth) Wedd.	M.	With stinging hairs
Pipturus argenteus (Forst.) Wedd.	M.	
CELASTRACEAE.		
Celastrus bilocularis F. Muell	N.	
Denhamia pittosporoides F. Muell.	M.	
Siphonodon australe Benth.	MM.	
LORANTHACEAE.		
Loranthus dictyophlebus F. Muell.	N., E.	Parasitic
SANTALACEAE.		
Exocarpus latifolius R.Br.	M.	Root parasite
RHAMNACEAE.		
Alphitonia excelsa Reissek ex Endl.	M.	

TABLE 1—*continued.*

THE SPECIES OF THE CLOSED FOREST COMMUNITIES AND ECOTONES—*continued.*

Species.	Life-form.	Remarks.
AMPELIDACEAE (VITACEAE).		
Cayratia acris (F. Muell.) Domin	M-MM.	Liana
Cayratia clematidea (F. Muell.) Domin	M.	Liana
Cissus antarctica Vent. ..	MM.	Liana
Cissus opaca F. Muell. ..	M.	Liana
Tetrastigma nitens (F. Muell.) Planch.	MM.	Liana, with aerial roots
RUTACEAE.		
Melicope neurococca F. Muell.	M.	
Microcitrus australis (A. Cunn.) Swingle	M.	Thorny
Xanthoxylum brachyacanthum F. Muell.	M.	Thorny
SIMARUBACEAE.		
Ailanthus malabarica DC...	M.	Rosette tree, with pinnate leaves
MELIACEAE.		
Dysoxylon sp.	MM.	
Flindersia australis R.Br.	M-MM.	When MM. slightly buttressed; at least partly deciduous
F. collina F. M. Bail ..	M.	Deciduous or partly deciduous
F. Schottiana F. Muell. ..	M.	
Melia dubia Cav.	M.	Deciduous
Turraea pubescens Hellen...	N.	Deciduous
SAPINDACEAE.		
Alectryon connatus (F. Muell.) Radlk.	M.	
A. tomentosus (F. Muell.) Radlk.	M.	
Atalaya hemiglauca (F. Muell.) F. Muell. ex Benth.	M.	Seen chiefly as seedlings
Cupaniopsis parvifolia (F. M. Bail.)	M.	
Dodonaea cuneata Rudge ..	N.	Ecotone sp.
Ellatostachys xylocarpa (A. Cunn.) Radlk.	N.	
Harpullia pendula (Planch.) F. Muell.	M-MM.	
Jagera pseudorhus (A. Rich.) Radlk.	M.	Deciduous
Mischocarpus pyriformis (F. Muell.) Radlk.	M.	
ANACARDIACEAE.		
Euroschinus falcatus Hook. f.	MM.	
Rhodosphæra rhodanthema (F. Muell. ex Benth.) Endl.	M.	
ARALIACEAE.		
Polyscias elegans (Moore & F. Muell.) Harms	M.	Rosette tree, with pinnate or bipinnate leaves
EPACRIDACEAE.		
Trochocarpa laurina (Rudge) R.Br.	M.	
EBENACEAE.		
Diospyros pentamera (F. Muell.) F. Muell. & Woolls	M.	Frequently MM.
Maba fasciculosa F. Muell.	M.	
Maba humilis R.Br. ..	M.	
SAPOTACEAE.		
Amorphospermum antilogum F. Muell.	MM.	
Chrysophyllum pruiniferum F. Muell.	M.	
Lucuma sericea F. Muell. ..	M.	
MYRSINACEAE.		
Myrsine variabilis R.Br. ..	N-M.	
SYMPLOCACEAE.		
Symplocos sp.	M ?	One specimen seen
OLEACEAE.		
Jasminum didymum Forst.	M.	Liana
J. suavissimum Lindl. ..	M.	Liana
Notelaea longifolia Vent. ..	M.	
Olea paniculata R.Br. ..	M-MM.	
APOCYNACEAE.		
Alstonia constricta F. Muell.	M.	
Carissa ovata R.Br. ..	N.	Divaricate prickly shrub
Alyxia ruscifolia R.Br. ..	N.	Leaves very rigid and pungent
Parsonsia lanceolata R.Br.	M.	Liana
P. velutina R.Br.	M.	Liana
ASCLEPIADACEAE.		
Hoya australis R.Br. ex Treull.	S.	Liana
Marsdenia sp.	M.	Liana
Sarcostemma australe R.Br.	S.	Liana; leafless
RUBIACEAE.		
Canthium coprosmoides F. Muell.	M.	
C. lucidum Hook. & Arn...	M.	
Hodgkinsonia ovatiflora F. Muell.	M.	
Ixora Beckleri Benth. ..	M.	
Pavetta indica L.	M.	
Psychotria daphnoides A. Cunn.	N-M.	
Ps. loniceroides Sieb. ..	N-M.	
PLUMBAGINACEAE.		
Plumbago zeylanicum L. ..	N.	
GOODENIACEAE.		
Goodenia grandiflora Sims ..	Ch.	Ecotone sp.
SOLANACEAE.		
Duboisia myoporoides R.Br.	M.	
Solanum stelligerum Sm. ..	N.	
Solanum spp.	N.	
BIGNONIACEAE.		
Pandorea pandorana (Andr.) Van Steenis	MM.	Liana
ACANTHACEAE.		
Justicia sp. aff. *J. procumbens* L.	Ch.	
VERBENACEAE.		
Lantana camara L. ..	N-M.	Liana, or forming dense masses; introduced
Spartothamnus junceus A. Cunn.	N.	Small, divaricating, almost leafless
LABIATAE.		
Plectranthus australis R.Br.	Ch.	Somewhat succulent
COMMELINACEAE.		
Commelina biflorum R.Br.	Ch.	A creeping herb
FLAGELLARIACEAE.		
Flagellaria indica L. ..	M-MM.	Liana, with leaf-tendrils
ZINGIBERACEAE.		
Alpinia caerulea (R.Br.) Benth.	H.	
LILIACEAE.		
Dianella caerulea Sims ..	Ch.	Grass-like; in ecotone
SMILACACEAE.		
Rhipogonum sp.	M.	Liana
Smilax australis R.Br. ..	M.	Liana; prickly
PHILESIACEAE.		
Eustrephus latifolius R. Br. var. *angustifolius* (R.Br.) Benth.	M.	Liana
ARACEAE.		
Pothos longipes Schott ..	E.	Root climber
Gymnostachys anceps R.Br.	H.	Grasslike; in ecotone
DIOSCOREACEAE.		
Dioscorea transversa R.Br.	M.	Liana
XANTHORRHOEACEAE.		
Lomandra longifolia Labill. sens. lat.	H.	Grass-like; in ecotone

TABLE I—*continued.*

THE SPECIES OF THE CLOSED FOREST COMMUNITIES AND ECOTONES—*continued.*

Species.	Life-form.	Remarks.
AGAVACEAE.		
Cordyline terminalis (Jacq.) Kunth	N-M.	Rosette small tree
PALMAE.		
Calamus Muelleri Wendl. & Drude	MM.	Very prickly liana
ORCHIDACEAE.		
Dendrobium gracilicaule F. Muell.	E.	
D. speciosum Sm. ..	E.	
D. teretifolium R.Br. ..	E.	
Sarcochilus falcatus R.Br. ..	E.	
CYPERACEAE.		
Carex declinata Boott ..	H.	Grasslike; tufted; in ecotone
Carex inversa R.Br. ..	H.	Grasslike; loosely tufted
Carex longifolia R.Br. ..	H.	Grasslike; densely tufted
Cyperus enervis R.Br. ..	H.	Grasslike; tufted
C. gracilis R.Br.	H.	Grasslike: tufted
C. laevis R.Br.	H.	Grasslike; tufted; in ecotone
C. tetraphyllus R.Br. ..	H.	Grasslike; loosely tufted
GRAMINEAE.		
Ancistrachne uncinulata (R.Br.) S. T. Blake	H-N.	Somewhat shrubby
Aristida gracilipes (Domin) Henr.	H.	Densely tufted; chiefly ecotone
Brachiaria foliosa (R.Br.) Hughes	H.	Tufted
Chloris unispicea F. Muell.	H-Ch.	Densely tufted
Leptochloa sp.	H.	Tufted
Oplismenus imbecillis (R.Br.) Kunth	Ch.	Creeping and ascending
Panicum pygmaeum R.Br.	Ch.	Creeping and ascending; particularly on tracks
Paspalidium sp. aff. *P. distans* (Trin.) Hughes	H.	Densely tufted
Stipa ramosissima (Trin.) Trin.	H-N.	Almost bamboo-like

TABLE II.

PLANTS OF COMMUNITIES OTHER THAN CLOSED FORESTS.

The numbers in the third column (occurrence) refer to the corresponding communities of the Open Forest as treated in the text. A refers to Aquatic Vegetation, and F to the Fringing Communities; C indicates that the species also occurs in the Closed Forest; and E that it also occurs in the Closed Forest–Open Forest Ecotone.

Species.	Life-form.	Occurrence.
PTERIDOPHYTA.		
POLYPODIACEAE.		
Adiantum aethiopicum L. ..	H.	9, C
A. hispidulum Sw. ..	H.	9, C
Cheilanthes Sieberi Kunze ..	H.	1
Notholaena distans R.Br. ..	H.	1, 9
Doodia heterophylla (F. M. Bail.) Domin	H.	9
Davallia pyxidata Cav. ..	E.	9
Drynaria rigidula (Sw.) Bedd.	Ch-E.	9,
Pteris tremula Thunb. ..	H.	9
Pyrrhosia confluens (R.Br.) Ching	Ch-E.	9, C
P. rupestris (R.Br.) Ching ..	Ch-E.	9, C
GYMNOSPERMAE.		
CYCADACEAE.		
Macrozamia spiralis (R.Br.) Miq.	Ch.	7, E
ANGIOSPERMAE.		
CERATOPHYLLACEAE.		
Ceratophyllum demersum L.	HH.	A
VIOLACEAE.		
Hybanthus enneaspermus (L.) F. Muell.	Ch.	7
PORTULACACEAE.		
Portulaca oleracea L. ..	Th.	1
POLYGONACEAE.		
Polygonum decipiens R.Br.	Ch.	F
P. lapathifolium L. ..	Th	F
P. orientale L.	Th.	F
Rumex Brownii Campd. ..	Ch.	1, 2
AMARANTACEAE.		
Alternanthera nana R.Br. ..	Ch.	1
OXALIDACEAE.		
Oxalis sp. aff. *O. stricta* L...	G.	7
ONAGRACEAE.		
Jussiaea repens L. ..	HH.	F
HALORRHAGACEAE.		
Myriophyllum verrucosum Labill.	HH.	A
PROTEACEAE.		
Persoonia Mitchellii Meissn.	N.	7
MYRTACEAE.		
Angophora lanceolata Cav...	MM.	4
A. subvelutina F. Muell. ..	MM.	2
Callistemon viminalis Banks & Sol. ex Cheel	M.	F
Eucalyptus carnea R. T. Baker	MM.	7
E. decepta Blakely ..	MM.	1, 3 ?, 4
E. gummifera (Gaertn.) Hochr.	MM.	1, 4
E. hemiphloia F. Muell. ..	MM.	3
E. maculata Hook. ..	MM.	5
E. melanophloia F. Muell. ..	MM.	1
E. paniculata Sm. ? ..	MM.	8
E. propinqua Deane & Maiden	MM.	3 ?
E. punctata DC.	MM.	7, 8
E. racemosa Cav.	MM.	1, 5, 6
E. tessellaris F. Muell. ..	MM.	1,
E. umbellata (Gaertn.) Domin	MM.	2
Eugenia Ventenatii Benth.	M-MM.	F
Melaleuca bracteata F. Muell.	MM.	F
Tristania conferta R.Br. ..	MM.	7, 8
T. suaveolens (Gaertn.) Sm.	MM.	2, F
TILIACEAE.		
Grewia latifolia F. Muell. ex Benth.	N.	6
STERCULIACEAE.		
Brachychiton Bidwillii Hook.	N.	9, C, E

TABLE II—*continued.*

PLANTS OF COMMUNITIES OTHER THAN CLOSED FORESTS—*continued.*

Species.	Life-form.	Occurrence.
MALVACEAE.		
Malvastrum spicatum (L.) Gray	A. Ch.	1
Malvastrum coromandelinum (L.) Garcke	Ch.	1
Sida corrugata Lindl. ..	Ch.	5
Sida rhombifolia L. ..	Ch.	1, 5
S. subspicata F. Muell. ex Benth.	Ch.	3
EUPHORBIACEAE.		
Poranthera microphylla Brogn.	Th.	7
Phyllanthus minutiflorus Muell. Arg.	Ch.	2
Ph. similis Muell. Arg. ..	Ch.	9
CAESALPINIACEAE.		
Cassia mimosoides L. ..	Ch.	1
MIMOSACEAE.		
Acacia Maidenii F. Muell. ?	M.	7, E
A. juniperina Willd. ..	N.	7
PAPILIONACEAE.		
Castanospermum australe A. Cunn. & Fraser	MM.	F, C
Crotolaria linifolia L. f. ..	Ch.	1, 4, 5
Desmodium brachypodum A. Gray	Ch-N.	7
D. rhytidophyllum F. Muell. ex Benth.	Ch-N.	3, 5, 7
D. varians (Labill.) G. Don	Ch-N.	1, 2, 7
Glycine clandestina (Spreng.) Wendl.	Ch-N.	4, 6, 7
G. tabacina (Labill.) Benth.	Ch-N.	1, 2
Hardenbergia bimaculata (Curt.) Domin [*H. monophylla* (Vent.) Benth.]	Ch-N.	4, 7, 9
Hovea acutifolia A. Cunn...	N.	7
Indigofera australis Willd.	N.	7, 9
Kennedya rubicunda (Curt.) Vent.	Ch-N.	7
Lespedeza sericea (Thunb.) Miq.	Ch.	6
Oxylobium trilobatum (R.Br.) Benth.	N.	7
Psoralea tenax Lindl. ..	Ch.	2
Rhynchosia minima DC. ..	Ch.	1
Tephrosia purpurea Pers. ..	N.	7
Zornia diphylla (L.) Pers...	Ch.	1, 4
CASUARINACEAE.		
Casuarina Cunninghamiana Miq.	MM.	F
C. torulosa Miq.	M-MM.	6, 7
LORANTHACEAE.		
Loranthus pendulus Sieb. ..	E.	1, 2
SANTALACEAE.		
Exocarpus cupressiformis Labill.	M.	1
RHAMNACEAE.		
Alphitonia excelsa Reissek ex Endl.	M.	1, C
AMPELIDACEAE (VITACEAE).		
Cissus opaca F. Muell. ..	N.	7, C, E
UMBELLIFERAE.		
Didiscus incisus (Rudge) Hook.	G.	7
EPACRIDACEAE.		
Acrotriche aggregata R.Br.	N.	7
Monotoca scoparia R.Br. ..	N.	7
Trochocarpa laurina (Rudge) R.Br.	N-M	9, C
OLEACEAE.		
Jasminum suavissimum Lindl.	N.	3, C
RUBIACEAE.		
Richardsonia brasiliensis (Gomez) Hayne	G.	2
Spermacoce sp.	Ch.	7
COMPOSITAE.		
Erechthites arguta DC. ..	Th.	1, 6, 7
Erigeron canadensis L. ..	Th.	1, 2, 5
E. crispus Pourret (*E. linifolius* Willd.)	Th.	1, 2, 5
Glossogyne tenuifolia (Labill.) Cass.	G.	1, 2, 3, 7
Gnaphalium japonicum Thunb.	Ch.	1
Helichrysum apiculatum (Labill.) DC.	Ch.	1, 3, 5
H. bracteatum (Vent.) Andr.	Ch.	7
Lagenophora bellioides (Cass.) Domin	H-Ch.	2
L. stipitata (Labill.) Domin	H-Ch.	7
Vernonia cinerea Less. ..	Ch.	7
CAMPANULACEAE.		
Wahlenbergia multicaulis Benth.	Ch.	1, 2
GOODENIACEAE.		
Goodenia rotundifolia R.Br.	Ch.	7
SOLANACEAE.		
Solanum sp.	N.	3
GESNERIACEAE.		
Erythræa australis R.Br. ..	Th.	1, 5, 7
Limnanthemum indicum (L.) Thw.	HH.	A
ACANTHACEAE.		
Justicia sp. aff. *J. procumbens* L.	Ch.	1
MYOPORACEAE.		
Myoporum debile (Andr.) R.Br.	N.	3
VERBENACEAE.		
Lantana camara L. ..	N.	1, 9, C, E
Verbena venosa Gill. & Hook.	Ch.	1, 2, 5
LABIATAE.		
Brunella vulgaris L. ..	Ch.	1
Plectranthus australis R.Br.	Ch.	7, 9, C
HYDROCHARITACEAE.		
Hydrilla verticillata (L.) Casp.	HH.	A
Ottelia ovalifolia (R.Br.) L. C. Rich.	HH.	A
Vallisneria spiralis L. ..	HH.	A
JUNCAGINACEAE.		
Triglochin procera R.Br. ..	HH.	A
POTAMOGETONACEAE.		
Potamogeton crispus L. ..	HH.	A
P. javanicus Hassk. ..	HH.	A
LILIACEAE.		
Arthropodium paniculatum (Andr.) R.Br.	G.	1
Dianella cærulea Sims ..	Ch.	7, E
Laxmannia gracilis R.Br...	Ch.	1
Cæsia sp.	G.	9
SMILACACEAE.		
Smilax australis R.Br. ..	N.	9, C, E
PHILESIACEAE.		
Eustrephus latifolius R.Br. var. *angustifolius* (R.Br.) Benth.	N.	3, 7, 9, C, E
ARACEAE.		
Gymnostachys anceps R.Br.	H.	8, 9, E
TYPHACEAE.		
Typha angustifolia L. sens. lat.	HH.	A
XANTHORRHOEACEAE.		
Lomandra longifolia Labill. sens. lat.	H.	7, F, E
L. multiflora (R.Br.) J. Britten	H.	7, 9
Xanthorrhœa arborea R.Br.	M.	6
ORCHIDACEAE.		
Bulbophyllum sp.	E.	9
Cymbidium canaliculatum R.Br.	E.	1
Dendrobium Kingianum Bidw.	E.	9
D. linguiforme Sw. ..	E.	9
Liparis reflexa (R.Br.) Lindl.	E.	9
Sarcochilus falcatus R.Br.	E.	9, C

TABLE II—*continued.*

PLANTS OF COMMUNITIES OTHER THAN CLOSED FORESTS—*continued.*

Species.	Life-form.	Occurrence.	Species.	Life-form.	Occurrence.
JUNCACEAE.			*D. sericeum* (R.Br.) A. Camus	H.	1
Juncus polyanthemus Buchen.	H.	2	*Digitaria didactyla* Willd. ..	Ch-H.	1, 4, F
CYPERACEAE.			*D. divaricatissima* (R.Br.) Hughes	H.	5
Carex declinata Boott ..	H.	8, E	*D. orbata* Hughes ? ..	H.	1
Cyperus cyperoides (L.) O.K.	H.	2	*D.* sp. aff. *D. recta* Hughes..	H.	7
C. difformis L.	Th.	F	*Echinopogon ovatus* (G. Forst.) Beauv.	H.	7
C. eleusinoides Kunth ..	H.	F	*Enneapogon pallidus* (R.Br.) Beauv.	H.	1
C. enervis R.Br.	H.	F, C	*Entolasia stricta* (R.Br.) Hughes	Ch-H.	7, 9
C. exaltatus Retz.	H.	F	*Eragrostis Brownii* (Kunth) Nees	H.	1, 5
C. ferax L. C. Rich. ..	H.	F	*E. elongata* (Willd.) Jacq...	H.	1, 5
C. fulvus R.Br.	H.	1, 2, 5	*E. leptostachya* (R.Br.) Steud.	H.	1, 2, 3, 4, 5
C. gracilis R.Br.	H.	1, 2, 3, 4, 5, F, C	*E. parviflora* (R.Br.) Trin...	Th-H.	1
C. globosus All.	H.	F	*E. sororia* Domin	H.	2, 4, 5
C. mirus C. B. Clarke ..	H.	F	*Eremochloa bimaculata* Hack.	H-G.	1, 3
C. polystachyos Rottb. ..	H.	F	*Heteropogon contortus* (L.) Beauv. ex R. & S.	H.	1, 5
C. trinervis R.Br.	H.	F	*Hyparrhenia filipendula* (Hochst.) Stapf	H.	1
C. vaginatus R.Br. ..	H.	F	*Imperata cylindrica* (L.) Beauv. var. *Koenigii* Dur. & Schinz	G.	7, 9
Fimbristylis æstivalis (Retz.) Vahl.	Th.	F	*Leptochloa* sp.	H.	1, 9, C
F. bisumbellata (Forsk.) Bubani	H.	F	*Microlaena stipoides* (Labill.) R.Br.	H.	3, 8, F
F. gracilis R.Br. ? ..	H.	2	*Panicum effusum* R.Br. ..	H.	1, 5
F. monostachya (L.) Hassk.	H.	6	*P. fulgidum* Hughes ..	H.	3
Kyllinga triceps Rottb. ..	H.	2	*P. Mitchellii* Benth. ? ..	H.	F
Lepidosperma laterale R.Br. ?	H.	7	*P. queenslandicum* Domin..	H.	1
Scirpus lacustris L. ..	HH.	A	*Paspalidium distans* (Trin.) Hughes	H.	4, F
GRAMINEAE.			*P. gracile* (R.Br.) Hughes ..	H.	1, F
Agrostis avenacea Gmel. ..	Th.	F	*Paspalum dilatatum* Poir...	H.	2, F
Aristida acuta S. T. Blake	H.	1	*P. distichum* L.	Ch-H.	F
A. glumaris Henr. ..	H.	1, 4	*P. orbiculare* Forst. ..	H.	F
A. gracilipes (Domin) Henr.	H.	1, E	*Pennisetum alopecuroides* (L.) Spreng.	H.	2, F
A. ramosa R.Br.	H.	1, 2, 3, 5	*Poa australis* R.Br. ..	H.	1, 6, 7, 8
A. vagans Cav.	H.	3, 4, 7	*Sehima nervosum* (Rottl.) Stapf	H.	1
Bothriochloa decipiens (Hack.) C. E. Hubb.	H.	1, 2, 3, 5	*Sorghum leiocladum* (Hack.) C. E. Hubb.	H.	1, 6
B. intermedia (R.Br.) A. Camus	H.	1	*Sporobolus elongatus* R.Br.	H.	1, 2
Brachiaria miliiformis (Presl) Chase	Th.	4	*Themeda australis* (R.Br.) Stapf	H.	1, 5, 6, 7, 8
Capillipedium parviflorum (R.Br.) Stapf	H.	1, 5	*Tripogon loliiformis* (F. Muell.) C. E. Hubb.	Ch-H.	9
Cenchrus australis R.Br. ..	H.	1			
Chloris divaricata R.Br. ..	Ch-H.	1, 5			
Chloris gayana Kunth ..	Ch-H.	1			
Ch. truncata R.Br. ..	Ch-H.	1			
Ch. ventricosa R.Br. ..	Ch-H.	4			
Ch. sclerantha Lindl. ..	Ch-H.	1			
Cymbopogon refractus (R.Br.) A. Camus	H.	1, 6, 7			
Danthonia semiannularis (Labill.) R.Br. ?	H.	7			
Dichanthium affine (R.Br.) A. Camus	H.	1, 2			

SUMMARY.

The vegetation of the lower part of the basin of the Stanley River is described as the result of a fortnight's reconnaisance work. The area exhibits great variety in topography, petrology, soils and vegetation. In many cases time did not allow a sufficiently detailed study of all these factors to permit conclusions to be drawn as to all their interrelationships. Vascular plants only were studied, and four main units of vegetation are recognised—viz., Open Forest, Closed Forest, Fringing Forest, and Aquatic Vegetation. Nine major community-types are recognised in the Open Forest, distinguished primarily upon the dominant trees, the dominant perennial herbs, and the presence or otherwise of a shrubby undergrowth. There is also usually some correlation with the habitat. Lists of all species seen are given, giving firstly the most common species, and then those less generally distributed. The Closed Forests are divided into two main types. The characteristic features of these are described, and the more prominent species listed.

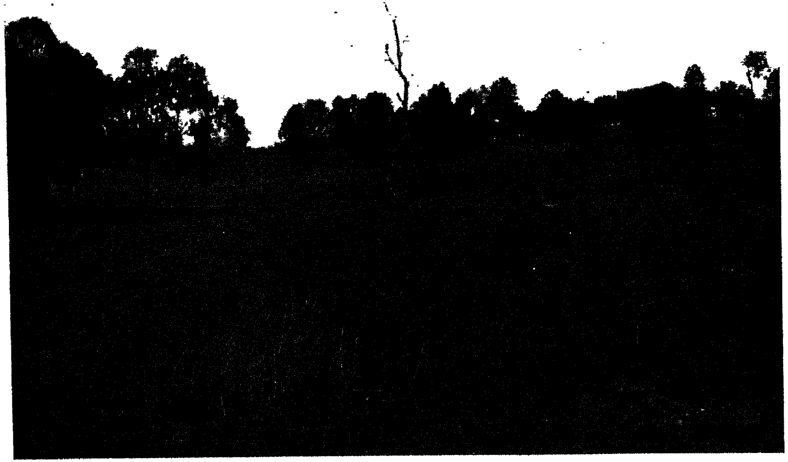

Fig. 1.—Partly cleared mixed eucalyptus forest (largely *E. tessellaris* and *E. melanophloia*), near Somerset Dam, on a podsol overlying porphyrite. The ground cover is chiefly *Bothriochloa decipiens* (the taller grass), *Digitaria didactyla*, and *Eremochloa bimaculata*.

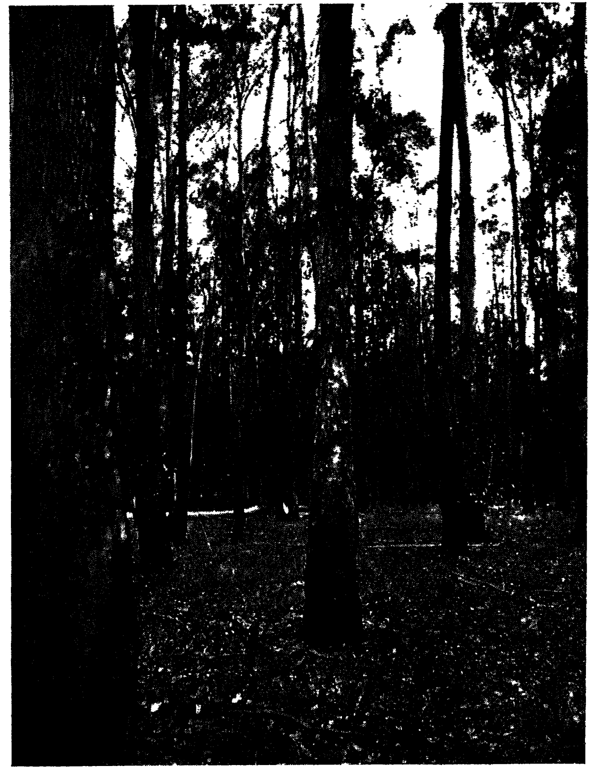

Fig. 2.—*Eucalyptus hemiphloia* forest, near Oakey Creek. Note the flat ground, the close spacing of the trees, and the sparse herbaceous vegetation, consisting chiefly of *Eragrostis leptostachya* and *Aristida vagans*.

[*Photos.*: S.T.B.

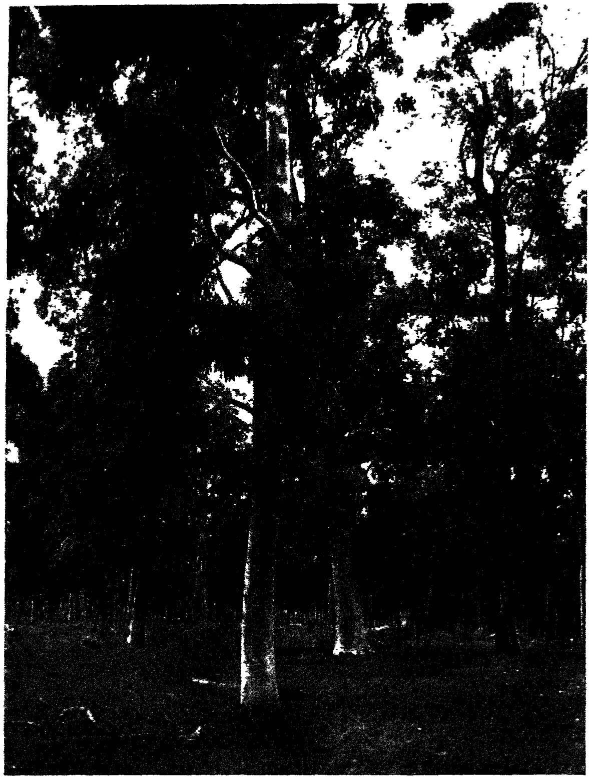

Fig. 3.—*Angophora lanceolata* forest, north of Somerset Dam. A tree of *Eucalyptus decepta* to the right. The ground cover consists of chiefly *Aristida vagans*, *Eragrostis leptostachya*, *Cyperus gracilis*, *Glycine tabacina*, &c.

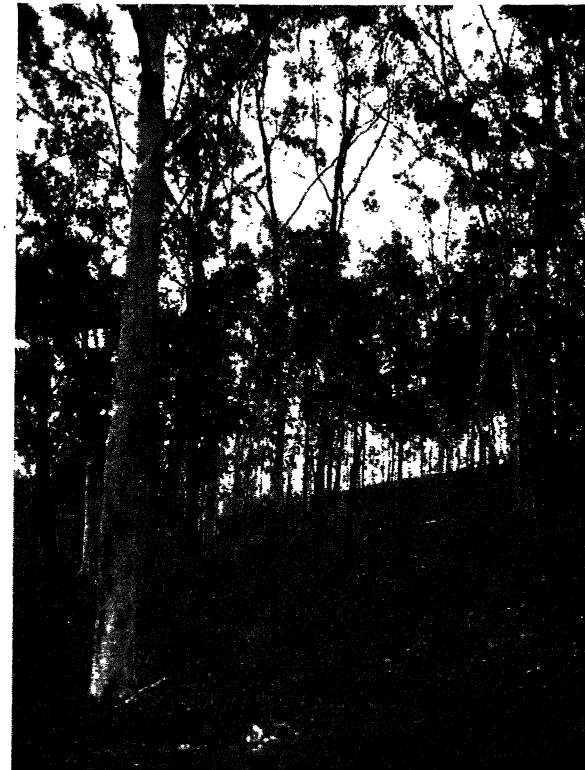

Fig. 4.—*Eucalyptus maculata* forest, near Reedy Creek. Some *E. melanophloia* in centre distance. Note the stony surface.

[Photos.: S.T.B.

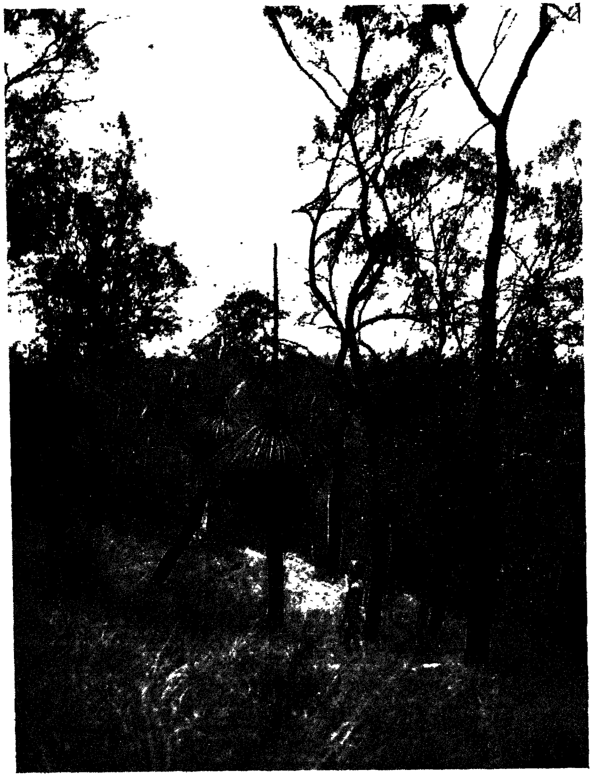

Fig. 5.—*Eucalyptus racemosa–Casuarina–Xanthorrhoea* forest, on upper slope of Little Mount Brisbane. The grass is chiefly *Themeda australis*, and the small shrub in the foreground is *Grewia latifolia*.

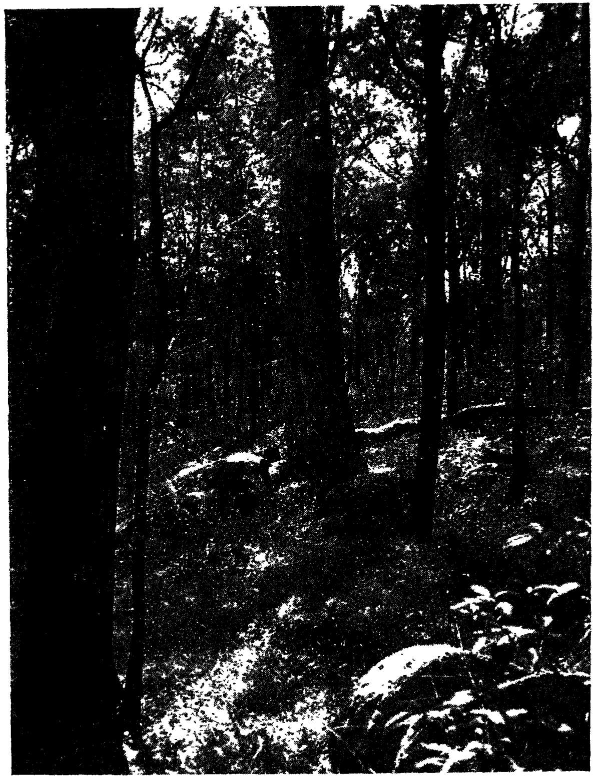

Fig. 6.—Forest of *Eucalyptus carnea* (stout trees) and *Casuarina torulosa* (the slender trees), on range to the west of Somerset Dam at 1,730 feet on rocky slope on dark-grey loamy sand. Note the undergrowth of chiefly *Oxylobium* and *Acrotriche*. In extreme right foreground is young *Tristania conferta*.

[*Photos.: S.T.B.*

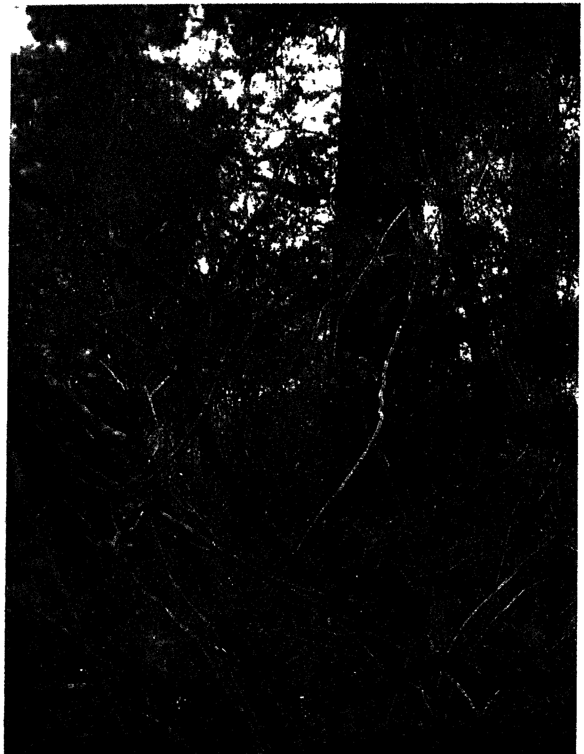

Fig. 7.—Interior of a " Pine Scrub " on Little Mount Brisbane at 1,000 feet. In right background is a large tree of Hoop Pine (*Araucaria Cunninghamii*). Note the lianas, chiefly *Cissus antarctica* and other *Ampelidaceae*.

Fig. 8.—In closed forest (approaching rain forest) on a spur of Mount Brisbane at about 700 feet. The tree at left is *Flindersia collina*. The stouter lianas are *Ampelidaceae*, the very slender one is *Tragia novae-hollandiae*.

[*Photos.: S.T.B.*

Fig. 9.—A small closed forest community in mixed eucalyptus forest (chiefly *E. tessellaris* and *E. melanophloia*) on hillside, about 4 miles north of Somerset Dam. Open forest at right and left.

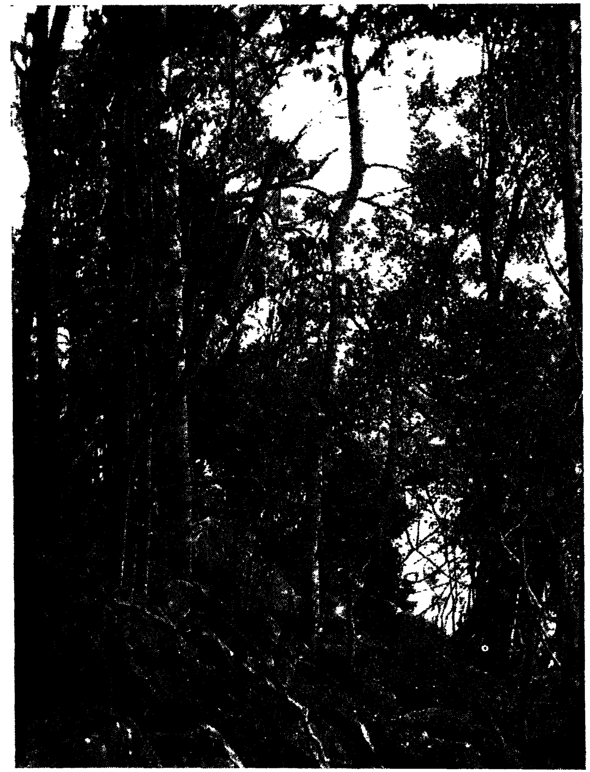

Fig. 10.—Within the closed forest community shown in Fig. 9. Note the rocky surface. The larger trees are chiefly *Laportea photiniphylla*, and the liana in extreme left foreground is *Hoya australis*. [*Photos.: S.T.B.*

Fig. 12.—Fringing forest of chiefly *Melaleuca bracteata* on the banks of Reedy Creek.

Fig. 11.—Near Somerset Dam, a very young closed forest community.

[*Photos.: S.T.B.*

The relationships of the Closed Forest communities to one another and to Open Forest are discussed. Several Fringing Communities are briefly described, all of which depend for their existence upon their proximity to water-courses. Aquatic vegetation was not studied in detail. Finally, two lists of species are given, the first containing all species recognised in the Closed Forests and their ecotones with notes on their habits, the second comprising those species found in the other communities, giving life-form and distribution.

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SPHERULITIC CRYSTALLIZATION AS A MECHANISM OF SKELETAL GROWTH IN THE HEXACORALS.

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(*Read before the Royal Society of Queensland, 25th November, 1940.*)

I. Introduction.

For some years the authors of this paper had been working independently on the structure of spherulites and of corals respectively. Certain similarities in structure were noted between these organic and inorganic materials which, even at first glance, appeared to be more than superficial. It was therefore decided to collaborate in making more detailed comparisons of coralline and spherulitic structures in order to determine the degree of similarity and its possible significance.

A search of the literature revealed that although the similarity between certain aspects of coral structure and spherulitic form has already been pointed out by von Koch (1882) Bourne (1899) and Cayeux (1916, p. 416) these authors do not appear to have appreciated the significant and indeed essential part played by spherulitic crystallization in coral growth.

Comparisons of the skeletal elements of organisms with mineral substances may be based on chemical, physical, or structural features, or on some combination of these.

The fact that a chemical identity exists between certain skeletal elements and various inorganic substances is, of course, well known and only to be expected. Even when the organic materials possess in addition crystalline forms identical with those of certain specific minerals, the fact need not be regarded as especially significant. But if, in addition to identity in chemical composition and crystalline form, there is found identity in the aggregation of the constituent crystals, it would appear that a study of that particular mode of mineral growth should throw some light on the organic processes producing the identical skeletal structure.

After a close examination of the microscopic characters of the skeleton of the Hexacoralla we have concluded that these organisms have adopted spherulitic crystallization as an essential mechanism of skeletal development.

II. The Skeleton of the Hexacoralla.

(a) Descriptive.

The skeleton of the Hexacorals is a framework whose constituent elements are aggregates of crystalline fibres of calcium carbonate. This is generally recognised and was established chiefly by the work of von

Heider (1882), von Koch (1882), Pratz (1882), Ogilvie (1897, 1907), Bourne (1899), and Duerden (1902, 1904).

The framework is constructed of vertical skeletal elements and of horizontal skeletal elements. It is bounded on its upper surface by the soft parts from which it was formed, but elsewhere it is typically sheathed in a thin calcareous film, the epitheca.

The various parts of the skeleton of a Hexacoral are closely comparable with those of the Rugosa, recently defined and illustrated (Hill, 1935). The vertical skeletal elements are the radially arranged septa, and, in many genera, the more or less complex axial columella; the horizontal skeletal elements of the Rugosa (tabulae, tabellae and dissepiments) may, however, sometimes in the Hexacorals have their functions performed in part by modifications or outgrowths of the vertical skeletal elements—e.g., synapticulae.

Chemical analyses of Hexacoral skeletons show that on the average they are 98 per cent. $CaCO_3$, with less than 1.5 per cent. $MgCO_3$, and only a trace of $Ca_3P_2O_8$ (Clarke and Wheeler, 1924 p. 8). Sorby's researches (1879) showed that the specific gravity of both perforate and non-perforate Hexacoral skeletons was about 2.75, and he therefore concluded that they must be almost wholly aragonite, although he was not quite certain that calcite is always entirely absent. Meigen's tests (1903) on twenty zoantharian corals showed them to be aragonitic and non-magnesian, and Cullis' (1904) work on the Funafuti bore cores confirmed this.

It has been suggested that Hexacorals in the chalk and Danian of Denmark had skeletons of calcite, because they still retain the original fibrous structure (Bøggild, 1930, p. 241, and Kendall (1896, p. 790) has suggested that chemical conditions at the bottom of deep, cold seas are such that only calcite could occur in skeletons formed there.

Microscopic investigation shows that the crystalline fibres are elongate needles about 2μ in diameter. They are not arranged haphazardly in the skeletal elements, but are grouped in systems.

In true horizontal skeletal elements the fibres are arranged at right angles to the top and bottom surfaces, so that in a flat plate they are parallel, but in a curved plate they are slightly divergent—e.g., *Stylophora*. A vertical section of such a plate studied by transmitted light frequently shows a dark band at the base, which, however, is by reflected light more uniformly white than the rest. In some cases septal or columellar vestiges occur in the horizontal skeletal elements, and such vestiges have a less simple arrangement of fibres.

In the vertical skeletal elements the fibres are grouped into trabeculae, which are themselves grouped to form the septa, &c. But whereas the arrangement of fibres within the trabeculae is always approximately the same, the dimensions and arrangement of the trabeculae themselves vary from genus to genus, or from species to species. Each trabecula is a cylinder tapering convexly at the top, and consists of fibres, usually curved, directed upwards and outwards from a common axis. The fibres usually reach the surface of the cylinder somewhat obliquely, but they are at right angles in the tapering top.

The trabeculae may all be in the vertical plane of the septum, in which case they may either all be parallel, or they may diverge, those of the axial part of the septum being directed upwards and inwards, and those of the peripheral part being directed upwards and outwards.

In some cases the trabeculae may diverge laterally from the median plane of the septum to project on either side of the septum as granulations. This second type of divergence may be opposite or alternate. Combinations of these several arrangements may occur, giving in some cases very complex septa.

In a very large number of Hexacorals, the so-called Aporosa, each vertical skeletal element is formed so that the fibres of any one of its trabeculae are everywhere in contact with those of neighbouring trabeculae. In the others, the "perforate" Hexacorals, gaps are seen between the fibres of neighbouring trabeculae and sometimes the vertical continuity of a trabecula may be broken.

A lamellaton, chiefly shown by slight colour differences and degrees of opacity, is sometimes observed in vertical sections of the horizontal skeletal elements. It is at right angles to the fibres and shows no great regularity of width from one lamella to the next. The general impression obtained with the low power objective is that the fibres are continuous through the lamellations, but with the use of higher power evidence of discontinuity is to be seen at the base.

Lamellation of a similar nature is frequently visible also in the trabeculae of the vertical skeletal elements. It is everywhere at right angles to the fibres; the width of the lamellae is variable; there may be a darkening (in transmitted light) at the base of a lamella; there is an impression of continuity of the fibres of successive lamellae, but closer study shows interruptions. The axis of each trabecula is visible in transmitted light as a darker line, but by reflected light it is more densely white. The "darkening" at the axes of trabeculae and at the bases of tabulae, dissepiments, and lamellae appears to be due to excessively finely divided matter interstitial to the fibres at these places.

A very fine, even lamellation, 3μ to 6μ wide, is to be observed in the less opaque parts of most Hexacorals.

The intimate structure of the epitheca, whether fibrous or not, is unknown.*

The bleached skeletons of Hexacorals are creamy-white in colour as seen in the hand specimen, but as viewed through the microscope they appear as yellow or light brown by transmitted light.

The preceding remarks applied to the skeleton proper, as developed in each of the many sections that we have examined. Some specimens, however, show in addition to the regularly arranged aggregates of yellow crystalline fibres a discontinuous and irregular aggregation of colourless granular crystals external to the skeleton proper. These crystals are of aragonite (?) and may form scaly, vermicular, or roughly prismatic groups.

(b) Relation of the Madreporarian Skeleton to the Soft Parts.

It is now generally accepted that the skeleton of the Madreporaria is an exoskeleton formed by the basal ectoderm; that the ectoderm is a unilaminar sheet, in which, in general, cell boundaries are not distinguishable; and that the crystalline fibres of the skeleton arise in a colloidal matrix secreted by, but external to, the ectoderm. The soft parts are attached to the skeleton by this gel and by the sucker-like

* The work of von Koch (1882) suggests to us, however, that the epitheca may be a single sheet of minute spheres, each consisting of aragonite fibres radially arranged.

desmoidal processes which extend through the ectoderm from the mesoglaea. These conclusions have not been reached without argument, which, however, has already been sufficiently reviewed (Bourne, 1899; Duerden, 1902; Matthai, 1918; Hill, 1935, p. 484).

All vertical skeletal elements are formed in invaginations in the basal ectoderm, and all true horizontal skeletal elements are formed below the unfolded basal ectoderm between these invaginations.* The apices of the trabeculae project into smaller hollows in the septal invaginations, and the apical parts of the trabeculae are built up therein; the trabeculae are thickened from the sides of the septal invaginations. The direction of the crystalline fibres of the skeleton is always perpendicular to the surface of the ectoderm at the place and time of their addition. The direction of curvature of the vertical skeletal elements is always perpendicular to the direction of curvature of any horizontal skeletal element which abuts on to it. The calcareous fibres forming the horizontal skeletal elements are not sharply separated from those laid down at the same time on the sides of a neighbouring septum by the sides of an invagination (Hill, 1936, p. 192). It can be established from the growth lamination of the various elements that the vertical growth of a trabecula is more rapid than the vertical growth of a horizontal skeletal element, and it is deduced that upward pressure is exerted on the polyp at the tops of the invaginations. The muscular stresses developed in the base of the polyp due to the greater vertical growth of the trabeculae are thought to be relieved at the critical point to prevent rupture by the periodic release of the attachment of the skeleton to the uninvaginated base (*loc. cit.* p. 191). The base rises to a new position, in equilibrium with the stress, and a new horizontal element is begun. Thus while the upward movement of the vertical skeletal elements is continuous, that of horizontal elements is intermittent.

III. Spherulitic and Allied Structures.

(*a*) Descriptive.

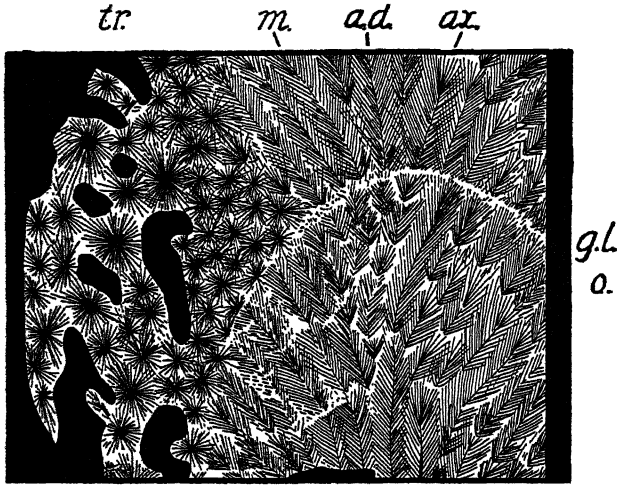
A spherulite, as originally defined, consists of "a radiating and often concentrically arranged aggregation of one or more minerals, in outward form approximating to a spheroid, and due to the radial growth of prismatic or acicular crystals in a viscous magma or rigid glass about a common centre or inclusion" (Vogelsang, 1872).† In accordance with the general practice of geologists the scope of this definition may be extended to include, in addition to radial growth about a point, divergent growth about an axis and parallel growth upon a surface and any combination of these.

Further, and in addition to such simply radial, divergent or parallel growths, other, composite, but obviously related structures are found. Such composite spherulites show the result of mutual interference between adjacent components in two types of growth that have been described as "tufted" and "plumose" respectively (Bryan, 1940, p. 46).

In the first of these types the centres from which the radial growths are directed remain fixed in their initial position and composite growth proceeds in the form of tufts, the fibres of adjacent components after initial antagonism become progressively longer and more nearly parallel,

* In some perforate Hexacorals, however, the function of the horizontal elements is wholly or in part taken over by modifications of the vertical skeletal elements.

† Cited from Holmes, 1928, p. 214.



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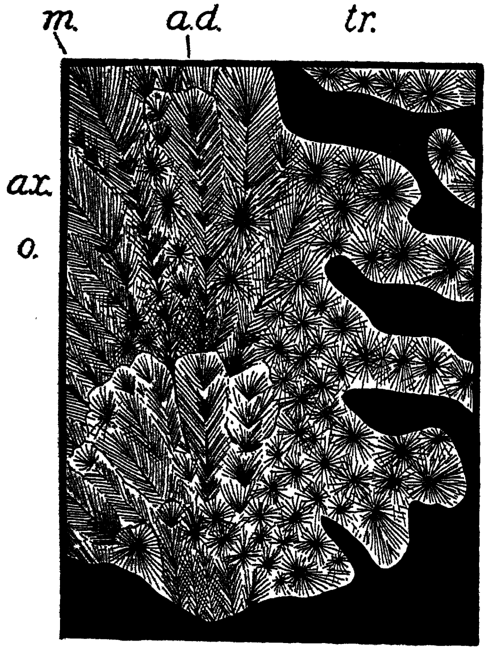


2.

EXPLANATION TO TEXT-FIGURES.

Each figure represents an almost vertical section through a septum of a Hexacoral, in the plane of the septum. In this species the trabeculae diverge towards the peripheral and axial edge of the septum, at *a.d.*, and they also diverge from the median plane of the septum to each septal face—i.e., they diverge into and away from the plane of the paper. Each trabecula consists of crystalline fibres of Aragonite directed upwards and outwards from its axis *ax.* Trabeculae cut transversely by the section are shown below *tr.* in each figure as radiating groups of fibres; others cut in an approximately median vertical plane are shown at *m.* in each figure as pinnate aggregates; and others again, cut obliquely, are shown opposite *o.* in each figure as fan-shaped groups of fibres. Discontinuity due to interruption in growth is shown at *g.l.*, which represents the position of the upper edge of the septum at that growth period. After Ogilvie. These figures should be compared with those illustrating various types of spherulitic growth given by Bryan in an earlier paper in this volume (Proc. Roy. Soc. Qld., LII., pp. 41-53).

and the whole structure moves toward a unity and homogeneity that resembles more and more closely simple spherulitic growth. Correspondingly the outer surface becomes more and more nearly that of a simple sphere.

In the second type the centres of radial growth move progressively outwards from their original positions, the adjacent components remain as antagonistic as when they first interfere, and the structure remains an obviously composite one with a complex outer form.

Concentric structures frequently accompany spherulitic growth. These are however by no means essential. They in no way contribute towards the radial growth, but, on the contrary, may be regarded as interruptions of it.

Such interruptions may be brought about in several ways and may be periodic or haphazard, giving rise to concentric patterns of varying degrees of regularity.

The foregoing statements apply to spherulites proper as they occur in natural rock glasses, but similar crystal aggregates dominated by radial fibrous growth are found under quite other conditions in the mineral world. It may be that in some of these the resemblance is little more than mere superficial similarity, while others may represent true homologues of the spherulites proper. Much work remains to be done to elucidate the position. Here it will be sufficient to refer briefly to a few examples typical of these analogous structures.

Of the non-metallic minerals Wavellite is perhaps the best example, while all the essential features of spherulitic structure appear to be present in some varieties of the iron ores Siderite and Haematite. Hailstones are sometimes in the form of radial aggregates. "Spherulites" have been formed, too, by the deposition of Aragonite in sea water.

Structures analogous to natural spherulites have also been produced artificially. They have been accidentally formed from time to time in commercial glasses. Morse, Warren, and Donnay (1932) have deliberately developed them in gels, in which medium they have succeeded in producing perfect specimens from a host of different chemical substances of every crystal system. Spencer (1925, p. 689) has grown "spherulites" in test tubes from supersaturated solutions of salicin containing (1) flocculated clay, (2) bentonite, (3) a gelatine-gel.

(*b*) Conditions of Spherulitic Growth.

It is difficult to state any one set of conditions that will cover the development of spherulites proper and the many inorganic structures more or less closely analogous to them. But, although one cannot define the essential conditions of spherulitic growth one may at least indicate those conditions that appear particularly favourable for its development.

Thus for the spherulites proper it is generally agreed that development is dependent upon crystallisation of highly supersaturated material in a very viscous solution. The same conditions would appear to be true for the accidental development of spherulites in artificial glasses.

Spencer (1925, p. 705) concludes with regard to spherulitic siderite in sediments that "The radiating spherulitic form of the carbonate appears to be due to crystallisation from supersaturated solutions held within partly colloidal sediment."

With regard to the production of artificial spherulites Morse, Warren, and Donnay have shown that they can be formed of many substances if the reacting solutions are allowed to mix by diffusion avoiding all convection. They state further that the presence of a gel appears to be highly favourable to the growth of artificial spherulites.

Schade (*fide* Bucher, 1918) has demonstrated experimentally that concretionary bodies form when a substance passes from the state of an emulsion colloid (or "emulsoid") to that of a solid, and that if the change leads to the crystalline state the resulting structure is radial if the substance is pure. Weimarn (*fide* Hedges, 1931) has advanced evidence for the conclusion that many gels contain numerous spherical aggregates of crystal fibres as essential constituents. Bradford (*fide* Spencer, 1925), too, believes that gels themselves consist of microscopic spherulites.

While not denying the possibility that closely analogous structures may be formed from ordinary solutions, it would appear from the evidence cited above that glasses, colloids, and gels present especially favourable environments for the production of spherulites. The common factor may well be as suggested by Morse, Warren, and Donnay that under such conditions convection currents are at a minimum and diffusion consequently very regular.

IV. Spherulitic Crystallization as a Factor of Skeletal Growth.

(*a*) Analogies between Skeletal Components and Spherulitic Structures.

The simplest structural unit in the skeleton of the Hexacorals is the fibre. Each fibre is composed of calcium carbonate and is crystalline in nature. More particularly, it has been established that each fibre is a single orthorhombic crystal of Aragonite. So much is generally accepted.

As has been shown above, spherulitic crystallization is a phenomenon common to many chemical substances (including calcium carbonate), and to all crystalline systems (including orthorhombic). It would appear then that there is no serious reason to exclude the possibility that the fibres of the madreporarian skeleton are essentially homologous with the crystals of a spherulite. Indeed, it is our opinion that each coralline fibre is identical in all important respects with a crystal in a spherulite.

These skeletal fibres have been interpreted by Ogilvie as bunched into aggregates that she terms fascicles, and which she regards as definite structural units. If, indeed, such fascicles exist they have no counterpart in spherulitic crystallization, but a careful study of Ogilvie's descriptions and figures and a detailed examination of our own material has failed to establish the existence of these as recognisable entities.*

In our view, the natural category next in complexity to the fibre is the trabecula. Each trabecula is an aggregate of fibres arranged about an axis. Sections transverse to the axis show a simply radial arrangement of the constituent fibres, whereas sections parallel to the axis show divergent structure. We would suggest that each trabecula is to be compared with a spherulitic growth of axiolitic type.

The aggregation of trabeculae gives rise to such skeletal elements as the septum and the columella in the manner detailed earlier in the

* One of us (Hill, 1935) found no place for fascicles in her structural analysis of the coral skeleton.

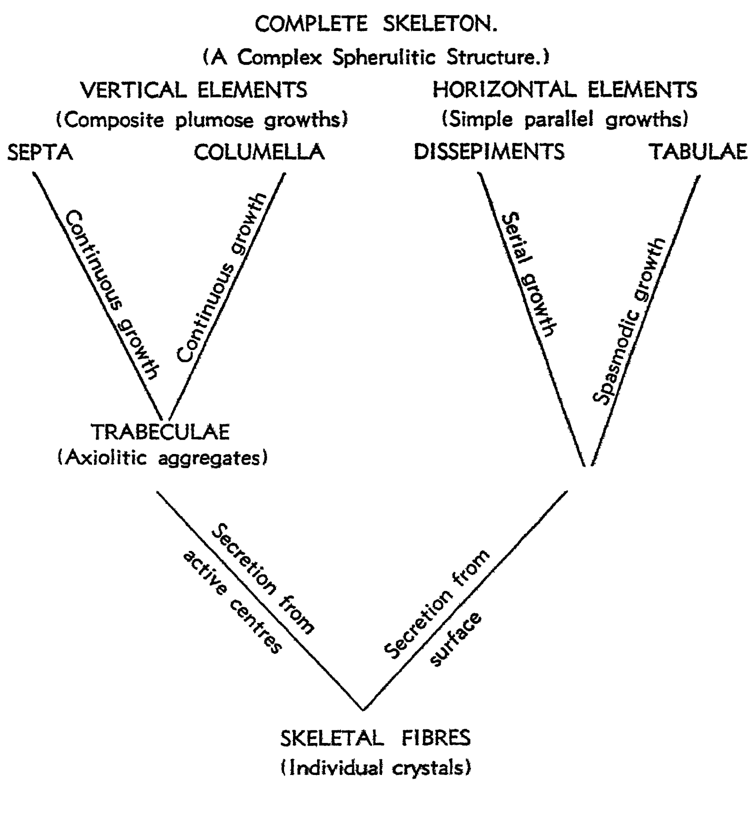
paper. It is our view that these trabecular aggregates are in all essentials closely analogous with composite spherulitic growth and more particularly with that manifestation of it that one of us has described as "plumose growth." It would thus appear that for septal growths each structural category—namely, fibre, trabecula, and septum—has its respective counterpart in spherulitic crystallization.

The columella in its complex fibrous trabeculae is closely comparable with a development of intertwined axiolitic growths.

The position with regard to the horizontal structures is somewhat different. Here the individual fibres are not aggregated into trabeculae, but appear as numerous closely parallel individuals arranged at right angles to the surfaces of the particular skeletal element of which they are units. Such pilose aggregations of fibres bear a striking resemblance to simple spherulitic growth upon a plane.

The lamellar markings and discontinuities, too, are analogous, both in appearance and relationship to the general plan, with those concentric arrangements that so frequently are found accompanying spherulitic structures.

The above conclusions are based on an examination of material especially prepared for the purpose, but it should be pointed out here that many published figures of hexacorallan skeletons, and in particular those of Ogilvie (1897), clearly and adequately demonstrate the many features in which they closely resemble spherulitic structures.



(b) The Growth of the Skeleton.

(i.) *General.*—Our interpretation of the development of the madreporarian skeleton in terms of spherulitic crystallization is as follows:—

In general, the whole ectodermal surface is capable of the slow exudation of a gel from which crystalline fibres of calcium carbonate are deposited in spherulitic aggregates of simply parallel character, placed at right angles to the adjacent ectoderm, thus giving rise to a pilose (carpet-like) effect.

In particular, at certain points in the ectoderm, a more concentrated production of the calcareous gel takes place.* Corresponding with each such centre, an individual spherulitic growth is initiated and maintained.

In both types of spherulitic growth development will proceed automatically and along predictable lines once the process is initiated and as long as the supply of calcium carbonate is available, but the particular spherulitic pattern on which the skeletal growth is based is determined by the number and distribution of the active centres. This pattern is not uniform for all hexacorals, but neither is it haphazard. Indeed, it is very significant and reflects the fundamental organic plan of the animal.

The centres of calcification are in general arranged in linear groups which are themselves radially disposed, but the particular arrangement of the centres in each group, as to number and position, and of the radial groups themselves, varies and is an important specific character.

From the beginning, and as skeletal growth proceeds, the more recently secreted fibrous spherulitic aggregates will be in intimate and continuous contact with the living polyp by means of the gel from which the fibres were deposited. This not only covers the exterior of the growing exoskeleton but penetrates deeply within the interstices between the crystalline fibres. Such an intimate relationship between "mother liquor" and crystalline deposit is peculiar to the spherulitic type of crystallization and is characteristic of the artificial spherulites developed by Morse, Warren, and Donnay. In the case of the hexacorals it might serve the important purpose of preserving organic continuity between the organism proper and the exoskeleton it secretes.

Thus, the special features associated with spherulitic crystallization —namely, the automatic growth of crystal aggregates in organised groups and the intimate relationship retained with the mother liquor—enable the intraprotoplasmic direction of what is essentially an extra-protoplasmic activity. In this way we may reconcile the apparently paradoxical facts of a purely external skeleton with an elaborate specific pattern.

At and near its outer edge the skeleton, as shown in our material, is colourless and there is no visible sign of the parent gel.

But except for this clear outer margin the skeleton is normally yellow or brown in colour as seen by transmitted light. This colouration we think to be due to an organic stain derived from the parent gel and possibly due to its decomposition. If this be so the coloured portion of the madreporarian skeleton may be considered as no longer possessing any vital link with the polyp.

* There is no histological evidence known to us that we can cite in support of this conclusion.

would greatly reduce anthracnose development, although usually not without risk of producing a more or less superficial injury to the skin, which precluded their use in commercial practice. Evidently in these instances the fungicide penetrated sufficiently to exert some controlling influence on the sub-cuticular hyphae in spite of the protection afforded by the cutinized layer covering them. It is quite conceivable that further work along these lines will disclose a fungicide either in the form of a liquid or a gas, to which the fruit themselves will be tolerant, but which, when applied to the harvested fruit, will completely prevent the further development of all latent infections present.

VIII. THE APPRESSORIUM.

A number of fungi of different genera have been found to possess the capacity of forming adhesion organs or appressoria. They may be produced in connection with the vegetative mycelium, or more typically by the germ tube when their presence is usually an aid to the initial penetration of the host tissue. Appressoria formation is specially characteristic of the genera *Gloeosporium* and *Colletotrichum*. Species belonging to these genera from twenty-four different hosts were observed by Halstead (1893) to produce these organs, and the list has been added to considerably by other workers. The almost universal association of the appressorium with the two genera so largely responsible for the production of latent infections suggests that it is the possession of this organ which makes possible the employment of this particular type of infection by this group of fungi. A full understanding of the functions of the appressorium is therefore of importance in connection with the subject of latent infection.

1. The formation of the appressorium.

The appressorium of *G. musarum* is typical of the genus. Its appearance has already been described in connection with the histology of latent infection. The appressorium commences as a terminal swelling on the germ tube. This is at first club-shaped but soon broadens and develops a thick brown wall. The contents at first stain in the same manner as the mycelium, but as the wall thickens staining becomes more difficult. When strength and time of immersion are sufficient to allow penetration of the stain the contents of the mature appressorium stain deeply but irregularly.

When Gloeosporium spores germinate on the skin of the fruit or in a weak nutrient the germ tubes are short, unbranched, and are terminated by the appressorium (Plate XIII.). As two germ tubes may be produced by the spore, it is quite common for the number of appressoria to exceed the number of germinating spores. In a rich medium there is a tendency for the germ tubes to branch and extend freely, to develop secondary spores from the tips of short lateral branches, and to form comparatively few appressoria. In certain media where a moderate extension and branching of the germ tube occurs the appressoria may come to take up an intercalary position. In this case the appressorium produces from somewhere on its surface, usually in the vicinity of the germ pore, another hypha which has every appearance of being an extension of the original germ tube (Plate XIII., fig. 2). This process, which may be repeated, is probably homologous with the intercalary formation of a resting organ rather than the germination of a spore. In the true germination of the appressorium as seen in slide

preparations after a period of rest the mycelium is of a somewhat different type and is of indeterminate growth. It is again quite distinct from the extremely fine infection thread produced on the host plant.

Although briefly referred to by earlier workers, the significant facts of appressoria formation were first elaborated by Hasselbring (1906). He concluded from observations made on hanging drop cultures that the formation of appressoria is induced by contact stimulus, although in the presence of abundant nutrient material the germ tube loses its power to react to such stimulus and the formation of appressoria is inhibited. The spores of *G. musarum* readily illustrate this point. When germinated in a hanging drop those which remain attached to the slide so that the germ tube extends along its surface from appressoria readily, whereas those which fall to the lower side away from the glass form few or none. The reaction to contact stimuli is further illustrated by the manner in which the appressoria tend to form in the depressions and crevices between the epidermal cells and conform to the space available, thus increasing their power of attachment and resistance. (Plate XIII., fig. 3.)

2. The functions of the appressorium.

Opinions are somewhat divided regarding the function of the appressorium. Hasselbring (1906), who discusses this question at some length, points out that Frank as early as 1883 recognised the significance of these organs as regards promoting adhesion and gave to them the name of appressoria. Other early workers, such as Southwork, Halstead, and Clinton, considered them rather in the nature of resting spores. Halstead (1893) states that the thickness of the wall suggests a protective function, and instances the fact that at times the appressorium may develop into an aggregation of thick walled cells to all intents and purposes representing a sclerotium. Clinton (1902) regards them as chlamydospores. Hasselbring himself, although recognising that the appressoria are more resistant than ordinary conidia, places the emphasis on the fact that they are adhesive organs attaching the fungus to the host during the early stages of infection. More recently Biraghi (1934) has discussed the position and emphasises the part played by the appressoria in enabling the organism to resist adverse conditions.

The capacity for adherence exhibited by the appressorium is a matter of common observation. The resistance to the action of flowing water is easily demonstrated by germinating spores, either on the surface of the fruit or on a glass slide, and then subjecting them to washing. Some germination figures obtained during the course of an experiment carried out for other purposes illustrates the extent to which the appressoria may resist mechanical removal from the banana skin. Drops of a spore suspension of *G. musarum* were applied to circles on banana fruit in the usual way and germination allowed to take place for 18 hours. Some of the fruit were then dipped ten times in 50 per cent. alcohol, others lightly wiped ten times with a wet cotton wool pad and then dipped ten times in 50 per cent. alcohol, and others were left untreated. Counts made from two circles on each of 2 fruit gave the results set out in Table 6.

TABLE 6.

Treatment.	Total number of spores.	Spores germinated.	Spores ungerminated.	Appressoria
No treatment	918	661	257	361
Dipped in alcohol	947	763	184	463
Wiped and dipped in alcohol ..	9	8	1	225

It is obvious that the appressoria possess the power to resist mechanical removal, and, to explain this, suggestions have been made from time to time regarding the means by which the attachment is made. Some writers (Dey 1919, Leach 1923) have stated that the appressorium is held in contact with the surface of attachment by a gelatinous or mucilaginous secretion which may be seen enveloping it. In the case of *G. musarum*, stained preparations sometimes show the presence of an amorphous substance associated with the outside of the appressorium, but the nature of this and whether it is normally present are matters of uncertainty. If present, the substance is evidently resistant to the action of water and alcohol. Apart from the presence of a cementing substance, the shape of the appressorium would enable it to act as a sucking disc, while the peg-like projection from its base would form an additional means of attachment when embedded in the cuticle of the host plant. In those cases such as in the banana and mango, where the epidermis presents an uneven surface, the appressoria make their position still more secure by fitting themselves to the crevices formed by adjoining epidermal cells (Plate XIII., fig. 3).

The essential value of this firm attachment is not so much the mechanical retention of the appressorium on the surface, since this is not usually required for any long period, but is rather to form a support to the infection hyphae, which, if cuticular penetration is not a chemical process, must be provided with a firm backing during the early stages of infection.

That the appressoria are fitted for conservation and are able to resist adverse conditions has largely been a matter of assumption based on their appearance. Little experimental proof has been brought forward in support of this view. Birachi (1934) makes a special point of this function, stating that the organs are in consequence analogous to chlamydospores rather than appressoria. His reasons for taking this stand, apart from the morphological one, are based on his contention that they are developed in a medium weak in nutrients or poor in oxygen supply and as a defensive response to drying. These conditions are, however, not essential for appressoria production, and, moreover, it must be remembered that organs of conservation in the fungi, whether they be in the form of resting spores or sclerotia, are usually produced in anticipation of adverse conditions rather than in response to them.

If, as has been suggested, the appressoria are organs of conservation it is important from the practical point of view to know their reaction to drying and the action of chemicals. Hasselbring (1906) describes an experiment whereby he showed that the appressoria of the bitter rot fungus were more resistant to drying than the spores which did not survive a period of 24 hours. Dey (1933), on the other hand, states that the appressoria of *C. gloeosporioides* are unable to withstand drying.

Since the spores of *G. musarum* will give a fair germination after being dried for several weeks a comparison is not so easily made. Experiments carried out with this fungus and with *Gloeosporium* sp. from the papaw have proved conflicting, in some cases the appressoria possessing the longer life and in other the spores. The usual procedure adopted in this work was to prepare petri dishes by applying to marked areas 25 small drops of an appropriate spore suspension in sterile water or weak nutrient. Some of these were dried immediately while others were dried after appressoria had been established. Both series were then retained at laboratory temperature under similar conditions. After an interval of several days or weeks a suitable agar medium or germinating fluid was applied to the individual drop sites or to the plate as a whole and the germination of spores and appressoria subsequently determined by microscopic examination through the glass. The numbers of spores were kept low to facilitate observation.

One of these experiments in which the appressoria proved most resistant was described by Simmonds and Mitchell (1940). The results from this and two other series are included in Table 7. It is obvious that more knowledge is required regarding the conditions influencing the germination of the appressorium before such experiments can be relied on. Longevity should be greater on the fruit than on the surface of a dry slide. In nature it is doubtful whether any considerable longevity is called for, since germination of the appressorium and formation of a latent infection probably takes place within a few days or even hours of spore germination.

TABLE 7.

The effect of drying on spores and appressoria of Gloeosporium.

Series.	Fungus.	Period of drying (days).	Number of spores germinating	Number of appressoria germinating
1	*G. musarum*	21	0	40
2	*G. musarum*	6	13	1
	Gloeosporium sp. (ex papaw) ..	6	2	17
3	*G. musarum*	13	439	379

A knowledge of the resistance of the appressorium to fungicides is important, since, if such resistance were considerable, most of the arguments in favour of the occurence of latent infections would be negatived. Preliminary experiments which were described by Simmonds and Mitchell indicated that the appressoria are definitely more resistant to 50 per cent. alcohol than are the spores. Subsequent work has shown that they are resistant also to the action of other chemicals.

Plates were prepared as described above each with twenty-five circles containing dried films of either ungerminated spores or appressoria. These were subjected to flooding for a specified time with the fungicide under consideration, which was then allowed to evaporate or was removed by washing. A suitable germinating medium was then applied to the films and the subsequent growth determined by microscopic examination. The result of one such experiment is contained in Table 8. Each film contained on the average 60 spores, or, when they had been allowed to form, 85 appressoria. One plate was used for each treatment which was thus applied to a total of 1,500 spores or 2,000 appressoria.

TABLE 8.

The comparative effect of sterilizing agents on spores and appressoria of G. Musarum.

Treatment.	Total germination per plate.	
	Spores only.	Appressoria.
Sterile water, 15 seconds, then drained and dried ..	99	64
Formalin, 0·75 per cent., 15 seconds, then drained and dried	0	39
Alcohol 50 per cent., 15 seconds, then drained and dried ..	0	8
$HgCl_2$, 0·1 per cent., 30 seconds, then washed, drained, and dried	0	0

None of the fungicides used had a residual effect, and it might be argued that one such as Bordeaux mixture might prevent effective germination although not actually killing the appressorium. It has to be remembered, however, that on the host plant the appressorium is in intimate contact with the epidermis, and the germ tube by emerging from the lower surface has little opportunity of coming into contact with the fungicide before leaving its sphere of influence.

The conclusion arrived at from this work is that the appressorium is definitely more resistant to chemical action than the spores. Accordingly this needs to be taken into consideration when designing any experiment involving surface sterilization of the fruit. However, the number of appressoria surviving treatment is relatively small, and although their resistance either to fungicidal action or to drying may be a factor in the survival of the fungus in a few isolated instances the resistance of the appressorium can in no way be used as a theory to supplant that of latent infection.

Another function of the appressorium which may be included under the heading of conservation is to provide a reserve food supply. After the formation of the appressorium the contents of the spore and germ tube evidently come to be included within its walls, as is indicated by the reduced staining properties of the latter and the densely staining contents of the former. At the time of infection this material is available for the production of the infection thread and for the development and support of the infection hypha within the cuticle of the host plant. The time occupied in transferring this reserve supply through the narrow infection thread may partly account for the time taken to establish the sub-cuticular hypae satisfactorily.

3. CONCLUSIONS REGARDING THE NATURE OF THE APPRESSORIUM.

In addition to its function, the nature of the appressorium from the mycological point of view has been the subject of considerable discussion. Biraghi (1934) points out that three different names, each possessing rather a distinct significance, have been used amongst some eighteen different authors—namely, chlamydospore, secondary spore, and appressorium. Of these, the first and the last are in more general use. Since these organs can by no means be regarded as of use in distribution the term spore is scarcely applicable. The term chlamydospore is usually applied to a vegetative form of reproduction consisting essentially in the modification of one of the terminal or more commonly intercalary cells of the vegetative mycelium, which may enlarge and develop a thick and often coloured wall distinguishing it from the cells of the normal mycelium. The chlamydospore usually

functions as a resting spore, and may germinate by a germ tube when conditions are suitable. The typical appressorium may be similar in origin and appearance but is more often produced in a terminal position and by the germ tube. It functions as a holdfast formed as a response to contact stimulus and may serve as an important adjunct to the act of infection.

Since in the genera *Gloeosporium* and *Colletotrichum* the body in question may be of use both as a resistant organ and as a holdfast; there are arguments from the point of view of function for the use of both names. However, in the economy of the fungus the advantages derived from the power of adherence and aid to infection outweigh the others. That is to say, the organ functions as an appressorium rather than a chlamydospore.

From a consideration of homology the point of view is clearer. The production of several appressoria in series by one germ tube suggests the intercalary formation of a resting spore. Hasselbring (1906) states that in old exhausted cultures of *G. fructiginum* the hyphae may form a series of thick-walled irregularly-shaped cells of the nature of appressoria. These may be so crowded as to resemble sclerotia-like masses. Biraghi (1934) also calls attention to the formation in culture media by *G. olivarum* of brown organs, either singly or in small chains, which closely resemble the appressoria produced by the germ tube. The organs formed by the vegetative mycelium he regards as chlamydospores, and points out that there is little essential difference between the formation of these and the so called appressoria with which he considers them to be homologous. Mitra (1937) records that in the case of *C. curvatum* chlamydospores are formed abundantly in culture by the thickening of mycelial cells, and these closely resemble appressoria. There is, therefore, considerable evidence to suggest that the appressoria of *Gloeosporium* and *Colletotrichum* are homologous with chlamydospores and have been adapted from the more typical structure during the evolution of the type of infection process employed by members of these genera. Since their characteristic function is to act as holdfasts and aid infection they merit the distinctive name of appressoria.

IX. SUMMARY.

A review of the literature dealing with latent infection in tropical fruits reveals a lack of information regarding the possible duration of the period of latency and the manner in which the fungus maintains its dormant state.

By artificially inoculating immature banana fruit in the field it was proved that *G. musarum* could remain in a latent condition for five and a quarter months and then resume activity to produce typical anthracnose lesions as the fruit ripened. Only a proportion of the original infections may finally develop into ripe fruit spots.

Histological structures involved in latent infection are discussed and illustrated in relation to species of *Gloeosporium* and *Colletotrichum* on banana, papaw, and mango. A fine infection thread penetrates the cuticle direct from the appressorium and forms a hyphal structure adjacent to the cellulose wall of the epidermal cell. This sub-cuticular hypha is considered to be the form in which the fungus survives its period of latency.

Suggestions are put forward to explain the inability of the fungus to achieve active parasitism in the green fruit. The outer cellulose wall appears to form a barrier in the operation of which the constitution of the cell sap may play a part. An understanding of the nature of latent infection enables a clearer approach to be made to the solution of ripe rot problems. Several practical applications of the theory are discussed in this regard.

The appressorium is considered to be important in that its main function is to aid infection by providing a firmly attached reservoir from which the infection thread may be produced. It is more resistant than the spore to certain chemicals, and for that reason may be unaffected by some sprays. The appressorium is probably homologous with a chlamydospore, but in consideration of its function the use of the first mentioned name is permissible.

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EXPLANATION OF PLATES.

PLATE XII.

CAVENDISH BANANA FRUIT ARTIFICIALLY INOCULATED WITH *G. musarum* TO DEMONSTRATE LATENT INFECTION.

Upper three fruit: Bunch A, hand 1, inoculated 9.IV.40, harvested 3.IX.40. Lower three fruit: Bunch A, hand 4, inoculated 7.V.40, harvested 3.IX.40 (see text). In each series the upper fruit received no sterilization, the middle and lower were sterilized with 50 per cent. alcohol and 0.1 per cent. mercuric chloride, respectively, 6 days after inoculation. Photographed 12.IX.40 when sunken lesions were commencing in a few circles. Eventually typical anthracnose developed in all.

PLATE XIII.

THE DEVELOPMENT OF APPRESSORIA BY *G. musarum*.

FIG. 1. Spores germinating in an artificial dew on the surface of a banana. Note the formation of appressoria along the line of cell union (cf. Fig. 3). x 600.

FIG. 2. Spore germination in banana infusion on a slide. The original appressorium producing secondary ones by an extension of the germ tube. x 600.

FIG. 3. Vertical section through the epidermis of an artificially inoculated banana. Appressoria fitted into the angles between the cells.

FIG. 4. General view of spore germination and appressoria formation on the surface of a banana fruit.

PLATE XIV.

LATENT INFECTION STUDIES IN CONNECTION WITH THE INOCULATION OF GREEN UNSPRUNG BANANA FRUIT WITH A SPORE SUSPENSION OF *G. musarum*.

(All figures approximately x 1,000.)

FIG. 2. Vertical section through the epidermis after 66 hours at 23 degrees C. Cell and cell wall discolouration associated with the presence of appressoria. Note the proximity of the nuclei of adjacent cells.

FIG. 2. Vertical section through the epidermis after 66 hours at 23 degrees C. Appressorium in intimate contact with the cuticle, peg-like projection from the base, and a small mound-like thickening of the inner surface of the cellulose wall below the peg.

FIG. 3. Vertical section through the epidermis after 42 hours at 23 degrees C. Oval sub-cuticular hypha lying between cuticle and cellulose wall.

FIG. 4. Vertical section through the epidermis after 65 hours at 28 degrees. C. Sub-cuticular hypha in the angle between epidermal cells and associated with an appressorium lying on the cuticle.

FIG. 5. Oblique view of epidermal cell seen in a surface slice taken after 65 hours at 28 degrees C. when the fruit was well sprung. Probably represents the commencement of fungal activity with ripening. Infection thread leading to primary hypha lying entirely between cuticle and cellulose wall.

FIG. 6. View from above of surface slice of material similar to Fig. 5. Appressorium (out of focus in lower right corner) leading by infection thread to sub-cuticular knot and intercellular primary hypha which at its distal end (upper left hand) has penetrated deeper and is surrounded by a thickened cellulose wall.

PLATE XV.

INFECTION STUDIES WITH *C. lindemuthianum* ON FRENCH BEAN AND *C. gloeosporioides* AND *G. musarum* ON MANGO FRUIT.

FIG. 1. An appressorium of *C. lindemuthianum* (lower angular structure just out of focus) emitting a fine infection thread (scarcely discernible in photograph) which penetrates the epidermal wall direct and forms a conspicuous primary hypha within the epidermal cell. View from above of surface slice 72 hours at 20 degrees C. after inoculation. x 1,000.

FIG. 2. Similar material to Fig. 1. A primary hypha effecting the penetration of a lateral wall by a narrow projection. x 1,000.

FIG. 3. Four appressoria of *C. gloeosporioides* each emitting an infection thread penetrating the cuticle. Vertical section 45 hours at 29 degrees C. after inoculating ripening mango fruit. x 1,200 approximately.

FIG. 4. Infection thread from an appressorium of *C. gloeosporioides* about to form a sub-cuticular hypha. Note the zonation of surrounding cuticle. Vertical section 46 hours after inoculating green mango fruit. x 1,000.

FIG. 5. Infection threads from two appressoria of *G. musarum* penetrating the cuticle and commencing to form sub-cuticular hyphae. Note the clearing of the cuticle round the infection thread and the darkening of the adjacent cell walls in response to invasion. Vertical section 45 hours at 29 degrees C after inoculation of ripening mango fruit. x 1,000.

FIG. 6. Appressorium of *C. gloeosporioides* producing an infection thread and sub-cuticular hypha. Note the appearance of the surrounding cuticle and the browning of the cell wall to the right, probably in response to invasion from the two appressoria above. Vertical section 45 hours at 29 degrees C. after inoculating ripening mango fruit. x 1,000.

PLATE XVI.

INFECTION STUDIES WITH *Gloeosporium* SP. ON PAPAW FRUIT.

FIG. 1. Appressorium with a fine infection thread penetrating the cuticle and forming a sub-cuticular hypha within the thickened cellulose wall. Vertical section 25 hours after inoculating ripening fruit. x 1,800 approximately.

FIG. 2. Well developed sub-cuticular hypha. Vertical section 48 hours after inoculating hard green fruit. x 1,000.

FIG. 3. Seventy-two hours after inoculating hard green fruit. The fungus still in the sub-cuticular hypha stage. x 1,000.

FIG. 4. Seventy-two hours after inoculating ripening fruit for comparison with Fig. 3. Mycelium packing the superficial cells and an acervulus in course of formation. Note the sub-cuticular development of hyphae to the left. x 860 approximately.

PLATE XVII.

SUB-CUTICULAR HYPHAE DEVELOPED BY *G. musarum* ON BANANA FRUIT (FIGS. 1 TO 6) AND BY *Gloeosporium* SP. ON PAPAW (FIGS. 7 AND 8).

Drawings of vertical sections through the epidermis of inoculated areas. Reduced by half from an original magnification of approximately x 1,000.

FIG. 1. Material fixed 42 hours at 23 degrees C. after inoculating green unsprung banana fruit.

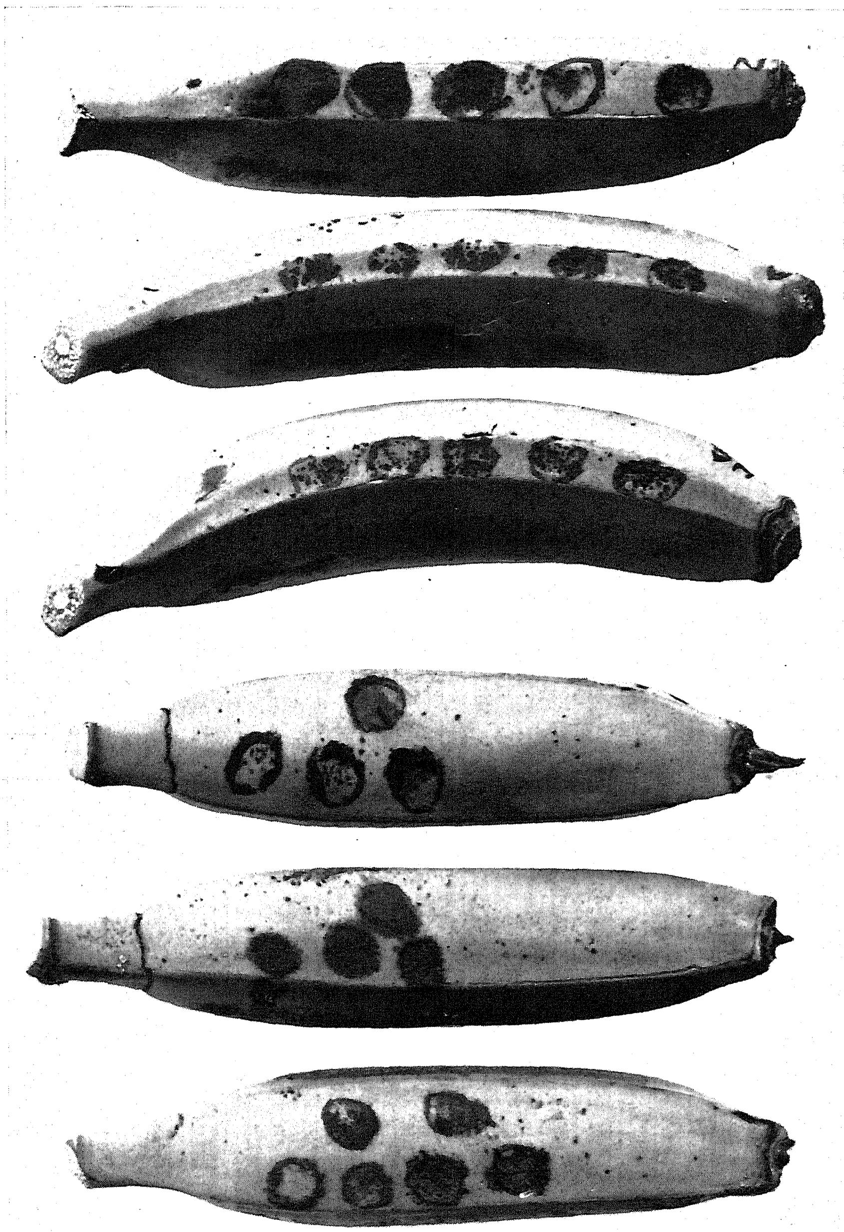
FIGS. 2, 3, and 4. Fixed 48 hours at 24 degrees C. after inoculating ripening fruit.

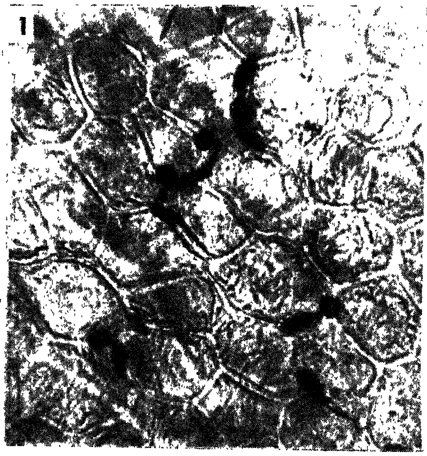
FIG. 5. Fixed 66 hours at 23 degrees C. after inoculating green unsprung fruit.

FIG. 6. Fixed 48 hours at 24 degrees C. after inoculating ripening fruit.

FIG. 7. Fixed 41 hours after inoculating ripening papaw fruit.

FIG. 8. Fixed 48 hours after inoculating green fruit.

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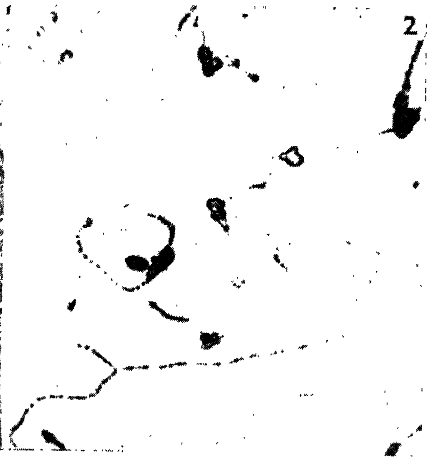
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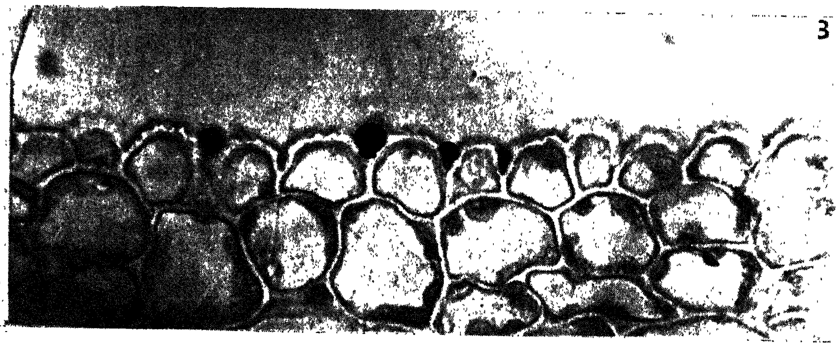
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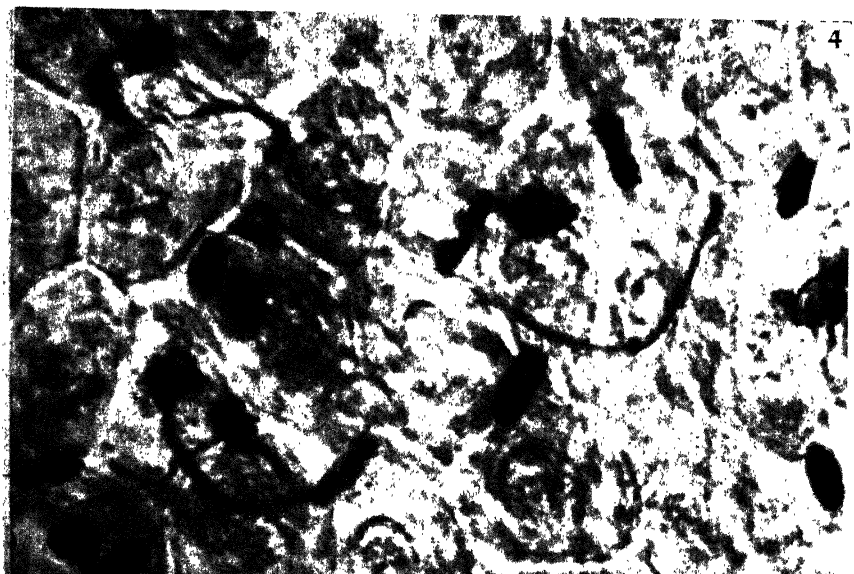
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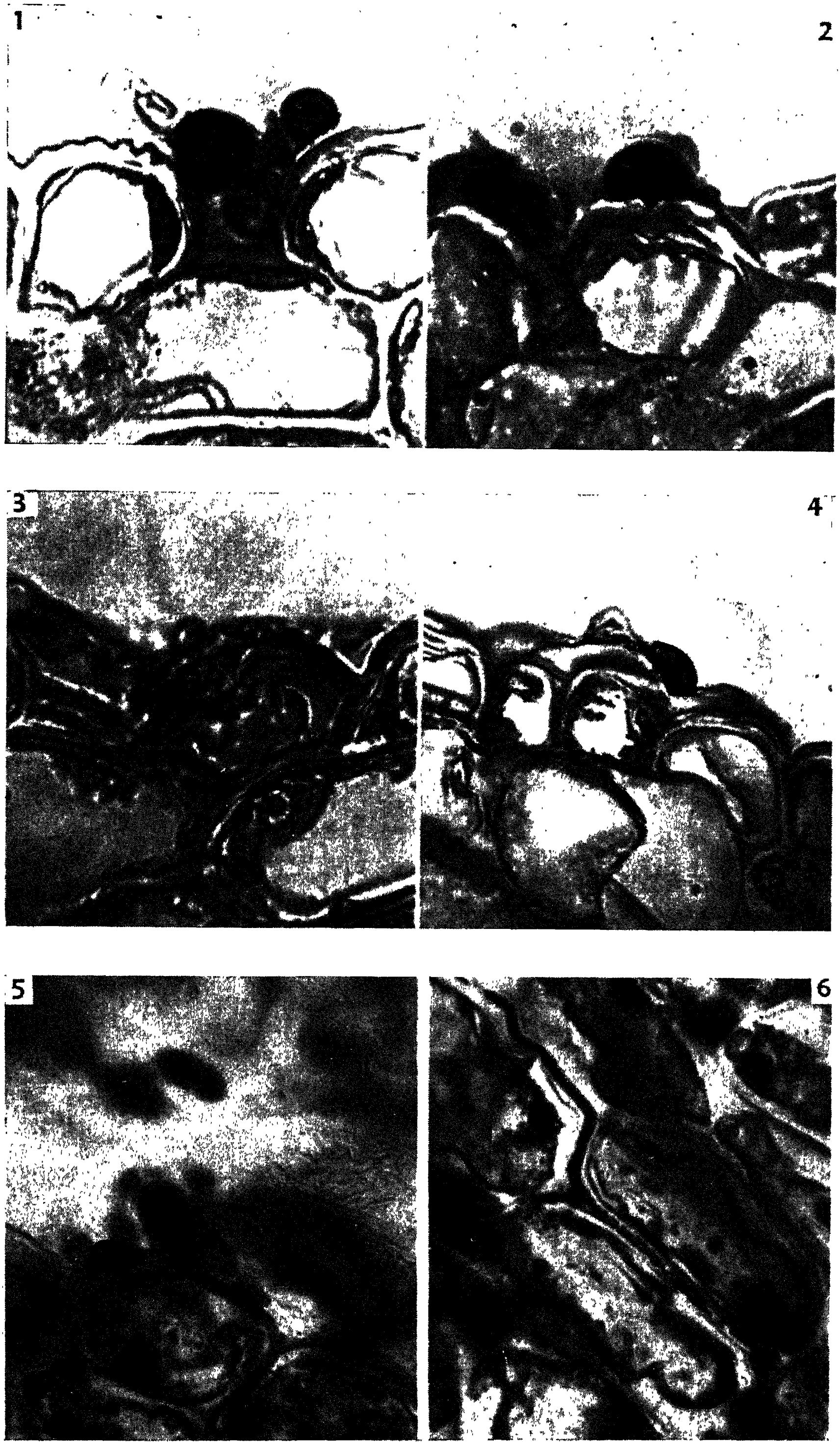
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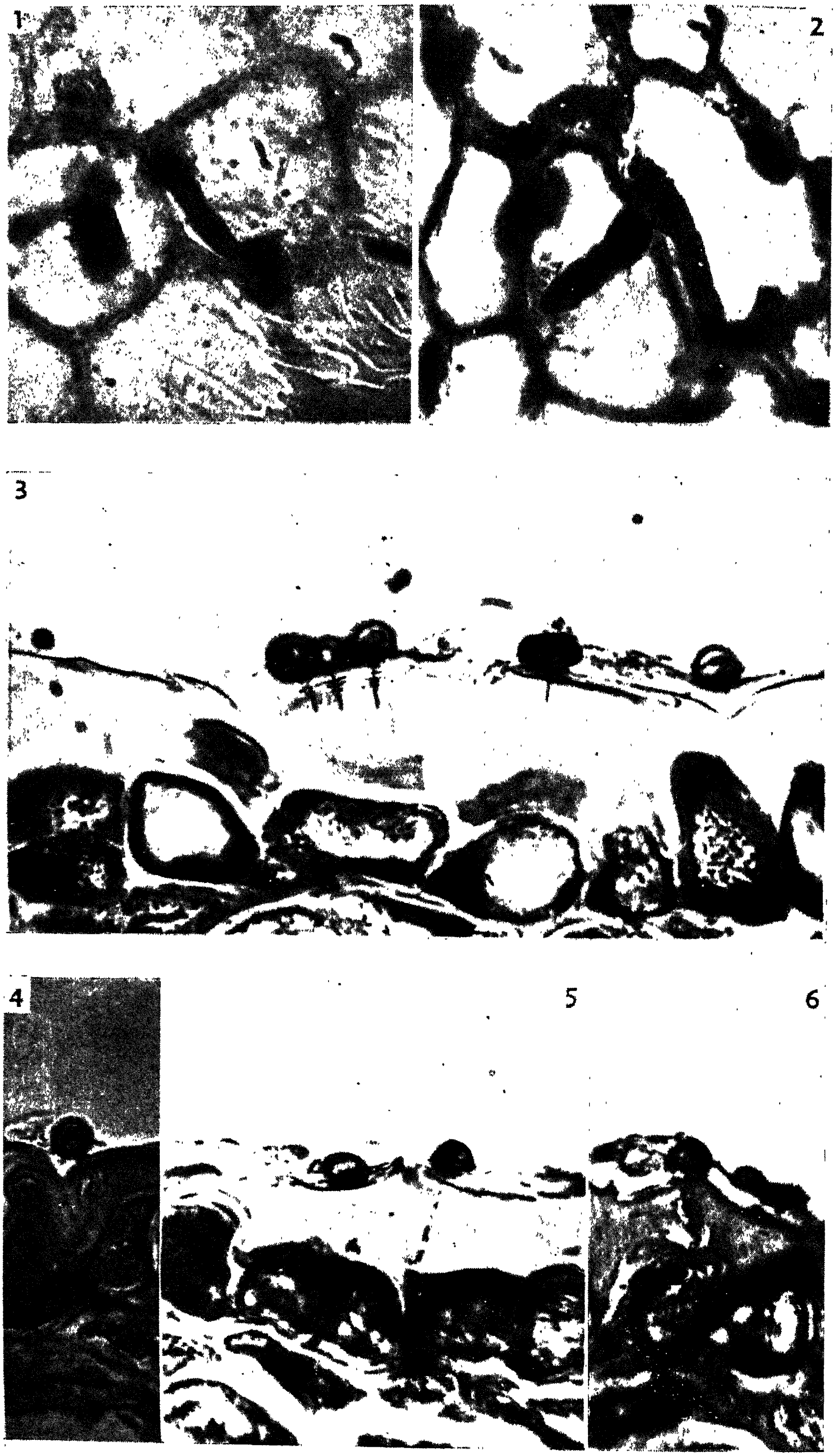
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Plate XVI.

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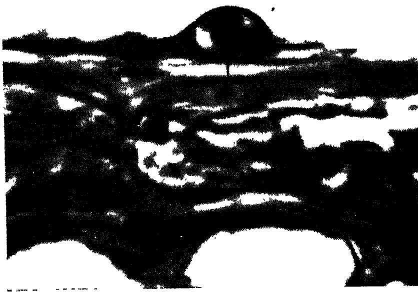

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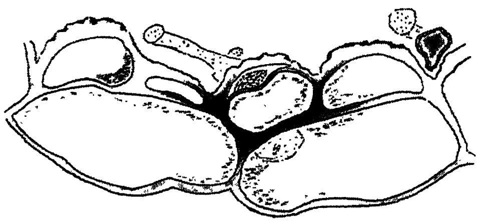

Fig. 1.

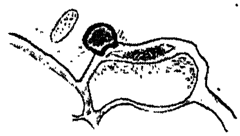

Fig. 2.

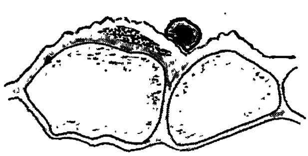

Fig. 3.

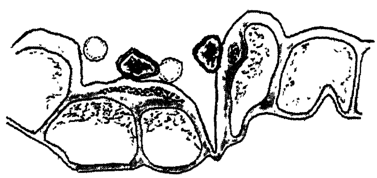

Fig. 4.

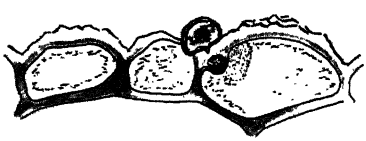

Fig. 5.

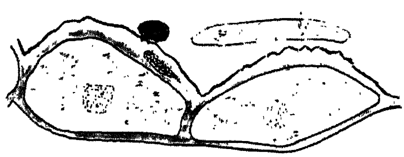

Fig. 6.

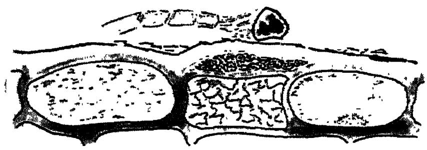

Fig. 7.

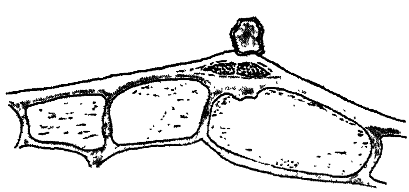

Fig. 8.

PRELIMINARY NOTE ON PHOTOSENSITISATION OF SHEEP GRAZED ON *BRACHIARIA BRIZANTHA*.

N. W. Briton,* B.V.Sc., and T. B. Paltridge, B.Sc.†

(*Read before the Royal Society of Queensland, 25th November,* 1940.)

Photosensitisation of sheep has been previously reported in Australia. This note is intended only to record observation of this condition, in sheep, grazed on pure stands of *Brachiaria brizantha.*

Brachiaria brizantha is a large, well-foliated, dark-green tussock grass, native to South Africa. It was introduced from Rhodesia by the Council for Scientific and Industrial Research, and has been selected as one of a number of species agronomically suited for use as a component of improved pastures for Southern Queensland. Its selection was based on preliminary studies extending over five years, during the last four of which it has been heavily grazed in mixed pasture by both sheep and cattle without noticeable detriment to the health of any animal.

The plots on which photosensitisation has been observed were established from seed in November, 1939. In common with other grasses, *Brachiaria brizantha* was planted in rows and has been maintained as a pure stand with the object of determining the comparative pasture value of selected species. On these plots the grass was allowed to reach maturity without grazing or other interference, beyond inter-row cultivation and removal of weeds. The mature growth was held throughout the winter months and over the heavy frosts experienced in July. The plots were cut on 12th August, 1940.

After cutting in August, plots remained untreated, while subdivision fences, &c., were being erected, until 22nd October. During this interval plants in more favoured areas made fairly vigorous growth to a height of 9 to 12 inches. In other areas (presumably drier) no new growth appeared. No other plants, beyond occasional nutgrass specimens (*Cyperus rotundus*), have been allowed to grow on these plots at all this year.

On 22nd October six crossbred wethers were driven on to a half-acre plot of *Brachiaria brizantha,* and on 23rd October another six crossbred wethers on to a second half-acre plot of this grass. By 30th October some sheep on both plots were noticeably sick, and on examination marked symptoms of photosensitisation were recorded. All sheep were then removed from *Brachiaria* plots and all were found to show definite symptoms of photosensitisation and icterus, marked by dropped ears, swelling of the subcutis of the face and eyelids, and congested, yellowish mucous membranes. The condition of these animals progressively degenerated until 11th November, at which time six had died.

All sheep were in good condition when driven on to the experimental plots, but with the onset of symptoms of photosensitisation, anorexia developed, and the sheep rapidly lost condition. In those that died the skin over the muzzle, ears, and eyelids was necrotic and

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the conjunctival sac filled with purulent exudate with consequent blindness. Post-mortem examination revealed marked icterus, involving all tissues, whilst the gall bladder was congested and filled with mucoid bile. In the case of four of these animals this condition resulted from eight days' grazing on *Brachiaria brizantha*: the other two animals were so affected after only seven days' grazing.

Similar groups of wethers grazing on adjacent plots of other grasses under exactly the same condition of shade, &c., remained in perfect health.

In view of the fact that no suspicion of photosensitisation has been observed in sheep previously grazed on *Brachiaria brizantha* when used as portion of a mixed pasture, the observations herein recorded are of considerable interest. It seems probable that, as with certain other species which are capable of giving rise to this condition in animals, *Brachiaria brizantha* will prove to be dangerous only under certain conditions of growth stage or aridity, &c.

An investigation of the problem is being undertaken by us.

The Royal Society of Queensland.

Report of Council for 1939.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1939.

Eleven original papers were read or tabled at Ordinary Meetings, and accepted for publication in the Proceedings; five lectures were given, and one meeting was devoted to exhibits. The average attendance was thirty-six, and suppers were served at a small charge to members.

In terms of the Government decision that the Chief Secretary's Department would pay a subsidy for printing on the basis of £1 for £1 up to a maximum of £150 per annum on papers of value from a Government point of view, the Society has this year received a subsidy of £72 from the Government on the volume for 1937. Also, the University made available £30 from the Walter and Eliza Hall Fund, towards the cost of publication of a paper by the Walter and Eliza Hall Fellow, Mr. S. T. Blake. These subsidies the Council acknowledges with gratitude.

There are at present 5 honorary life members, 5 life members, 4 corresponding members, 194 ordinary members, and 1 associate member. This year we have lost by death 2 members, and by resignation 3; 1 new corresponding member and 9 new ordinary members were elected.

There has been little progress with the arrangement of periodicals on the shelves. Two hundred and twenty periodicals were obtained by exchange.

The Society was represented at the Sixth Pacific Science Congress at San Francisco by Professor H. C. Richards, D.Sc., Vice-President.

Attendance at Council meetings was as follows:—E. W. Bick, 9; J. V. Duhig, 6; D. A. Herbert, 7; D. Hill, 8; H. A. Longman, 10; E. O. Marks, 8; F. A. Perkins, 8; H. C. Richards, 7; A. R. Riddle, 8; F. H. S. Roberts, 6; H. R. Seddon, 3; J. H. Smith, 7; M. White, 7.

H. A. LONGMAN, President.

D. HILL, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31st DECEMBER, 1939.

Dr.

RECEIPTS.

	£	s.	d.
Balance in Commonwealth Bank, 31st December, 1938	138	10	5
Subscriptions	136	10	0
Sales, Reprints, and Volumes	6	16	7
Subsidy from Walter and Eliza Hall Fund, per University, on Cost of Printing Paper by S. T. Blake	30	0	0
Interest on Commonwealth Loan	4	11	3
Savings Bank Interest	2	16	0
Exchanges	0	2	6
Donation from Professor J. V. Duhig for Bookbinding	18	2	6
Refreshment Account, Collections	4	2	9
	£341	12	0

Cr.

EXPENDITURE.

				£	s.	d.
Government Printer, Abstracts, Report, and Stationery				13	16	4
Government Printer, Volume 50	£206	9	0			
Less £72 Paid by Chief Secretary's Department	£72	0	0			
	£134	9	0	134	9	0
H. Pole and Company, Bookbinding				10	2	6
Honorary Secretary, Refreshment Account				5	12	4
Honorary Secretary and Librarian, Postages Account ..				3	7	8
State Government Insurance (Library)				0	19	2
Balance in Commonwealth Bank				172	17	6
Cash in Hand				0	7	6
				£341	12	0

Audited and found correct.

A. J. M. STONEY, B.E.E., Honorary Auditor.

E. W. BICK, Honorary Treasurer.

Abstract of Proceedings, 26th March, 1940.

The Annual General Meeting was held in the Department of Geology of the University on Tuesday, 26th March, 1940, at 8 p.m. with the President (Mr. H. A. Longman) in the Chair. Thirty members and friends were present. The minutes of the previous annual meeting were read and confirmed. The Annual Report was adopted on the motion of Mr. C. T. White. The Balance-sheet was received. Mr. Colin Clark, M.A., and Mr. L. S. Smith, B.Sc., were proposed for Ordinary Membership, and Mr. I. S. R. Munro and Mr. E. F. Riek for Associate Membership. The following officers and Council were elected for 1940:—President, Dr. F. W. Whitehouse; Vice-Presidents, Mr. H. A. Longman and Professor H. R. Seddon; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Miss D. Hill; Hon. Librarian, Miss K. Watson; Hon. Editors, Dr. D. A. Herbert and Mr. J. H. Smith; members of the Council, Professor D. H. K. Lee, Mr. F. A. Perkins, Professor H. C. Richards, Dr. F. H. S. Roberts, and Dr. M. White. Mr. A. J. Stoney was elected Hon. Auditor. The retiring President, Mr. H. A. Longman, inducted to the Chair the President-Elect, Dr. F. W. Whitehouse. The new President then called on the retiring President to deliver the address "Homo sapiens: turbulentus." Professor H. C. Richards and Dr. D. A. Herbert expressed to Mr. Longman the thanks and appreciation of the meeting for the address.

Abstract of Proceedings, 29th April, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 29th April, at 8 p.m., with the President, Dr. F. W. Whitehouse, in the Chair. About forty members and friends were present. Mr. J. W. Bleakley, Mr. V. Grenning, Mr. Colin Clark, M.A., and Mr. L. S. Smith, B.Sc., were elected Ordinary Members, and Mr. E. F. Riek and Mr. I. S. R. Munro Associate Members. Mr. K. V. L. Kesteven, B.V.Sc., and Mr. D. F. Gray, B.V.Sc., were proposed for Ordinary Membership by Prof. Seddon.

The main business was a Symposium, "Factors in the Settlement of the Brisbane River." Dr. W. H. Bryan pointed out that the chief reason for the settlement of the Brisbane River was the river itself, which provided a good harbour and a convenient waterway for the small craft of those days. Although it would appear from the early records that geological factors were not even considered when determining the site of Brisbane town, there existed nevertheless a number of geological facts all of which were favourable to such a choice. The earliest settlers found at hand several different types of building stones—e.g., the vari-coloured "Porphyry," the sandstone from Petrie's Quarry, and the Enoggera granite. Road metals were convenient and abundant, as were clays suitable for bricks and pottery. But more important than these were the extensive coal seams which were found some miles up the river. Perhaps the only serious geological deficiency was that of limestone which was needed for the production of lime and cement. After some search this was found at a place called Limestone Station, where the city of Ipswich now stands, but the limestone was poor and was not abundant. The soils in the area first settled were not uniformly good; nevertheless areas of excellent heavy black soils and lighter red soils enabled a relatively wide range of agricultural activities to be undertaken.

Dr. D. A. Herbert, in discussing the effects of European settlement on the native vegetation, pointed out that plant communities are by no means static, and that apart from geological evidence of past differences in distribution it was well established that the aboriginals had considerably altered the plant cover in many areas. The balds on the Bunya Mountains are regarded as grasslands induced by pre-European burning, and maintained by burning and grazing. Fire protection has in many instances resulted in a return of forest. The poverty of the native flora in plants of agricultural value and of the native fauna in domestic and potentially domestic animals was responsible for a sudden influx of enormous numbers of exotic plants, including weeds, and of animals with different grazing habits from those of the marsupials. The richness in species of trees in the rain-forests and the density of the stands was at first an obstacle to the utilisation of these lands because of difficulty of clearing and of the great variation of the timber. Commercial forestry operations have been directed more recently to the replacement of rain-forest with plantations of native (hoop pine, bunya pine, silky oak, &c.) and exotic trees in such areas. The work done on the mycorrhizal relations of some of these species has made possible the extensions of areas suitable for such planting. In particular, the investigations into the importance of mycorrhiza in connection with needle fusion of exotic pines have made possible a more efficient utilisation of sandy coastal soils for such species as *Pinus tœda* and *Pinus caribœa*. Work of a related nature on the nodule bacteria of legumes is giving valuable results in the establishment of such plants as lucerne and Poona pea in agricultural areas where the bacterial flora was previously unsuitable.

Mr. W. H. R. Nimmo said that engineering problems did not confront the early settlers, and those arising later are for the most part confined to the metropolitan area. Completion of Somerset Dam will provide an ample quantity of water for many years to come, but will only slightly reduce the average hardness; softening of the water is a problem for the future and, by elimination of the household tank, will contribute to the abolition of the mosquito. Those portions of the city which are outside the area drained by the present sewerage scheme must ultimately be served by independent schemes, the effluent from which must be purified and disposed of in the river, and the more regular flow of oxygenated water coming from Somerset Dam will have a value in this connection. The originally shallow and tortuous river has been converted into a port by cutting through the rock bar at Lytton, cutting off sharp bends and widening and deepening the channel. Since much of the cargo comes from or goes to the country, the tendency to-day is to build ocean terminals outside the city areas, where ample space is available for storage, thereby facilitating the handling of materials and reducing traffic congestion in the city. If shipping were the only consideration, such a development below Hamilton might have eliminated the cost of improving and maintaining the upper portion of the river and have made possible the construction of a number of low-level bridges. But maintenance of an adequate channel from the city to the river mouth is an essential factor in the reduction of flood heights, and therefore shipping will continue to use the upper reaches of the river. Wharfage, however, is gradually extending downstream and ultimately at least one other river crossing will become necessary, and possibly this will take the form of a tunnel somewhere between New Farm and Hamilton.

Professor J. K. Murray said that one of the important and early influences to come into play would be the *agricultural background* of the first group of settlers—a north-western European one with emphasis on the domestic stock and cool temperate crops of the British Isles and, to some extent and later, Germany. We have not yet completely adjusted agriculture to its sub-tropical environment in the Brisbane Valley. This *climatic feature* embraces fairly high annual rainfall, of unsatisfactory dependability and somewhat low efficiency, with much of it falling during a hot and long summer. Thus summer-growing crops rather than the winter cereals system, to which the early settlers were accustomed, gradually received the emphasis the conditions warranted. *Pastures* have been one of the least satisfactory features in the settlement of the valley. The native pastures are not good. Paspalum, Rhodes, Kikuyu, and white clover have played species parts; but systematic efforts to develop suitable pastures and systems of pasture management for sub-tropical conditions have only recently been initiated. *Stock* have been mainly confined to British breeds. Beef cattle have been largely replaced by dairy cattle, the cattle stations having been subdivided, closer settlement following. Better cattle and pigs and factories have improved returns. The valley is unsuited to Merinos, but British breeds and crossbreds do reasonably well. The increasing use of *machinery*, including refrigeration, has facilitated development of some areas and added to the diversity of production on others. *Settlement conditions* arranged by the Crown, although often deprecated, have been most favourable to settlement. *Irrigation* favours increased production. The Brisbane Valley system is of small pumping plants located on rivers, creeks, and wells. Electric direct-coupled units are common as a consequence of rural electrification schemes. *Markets.*—The metropolitan, State, Australian, and overseas markets have, of course, been a major factor, but the Brisbane market has, is, and will increasingly determine the agricultural activities of the valley.

Mr. C. T. White and Professor H. C. Richards contributed to the discussion which followed, and a vote of thanks to the speakers was moved by Mr. S. B. Watkins and Professor D. H. K. Lee and carried by acclamation.

Abstract of Proceedings, 27th May, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 27th May, with the Vice-President, Prof. H. R. Seddon, in the Chair. About forty members and friends were present. Messrs. K. V. L. Kesteven, B.V.Sc., and Mr. D. F. Gray, B.V.Sc., were unanimously elected into Ordinary Membership.

"The Petrology of the Somerset Dam Site," by C. W. Ball, M.Sc., was communicated by Mr. A. K. Denmead, M.Sc. The volcanic and intrusive rocks of the dam site, their mineralogy and inter-relations were described in detail, and the petrological reasons for the suitability of the site for a dam were given. Dr. E. O. Marks, Messrs. L. C. Ball, W. H. R. Nimmo, A. K. Denmead, and F. Gipps discussed the paper and indicated its value.

"Some Queensland Leaf-hoppers (Jassoidea, Homoptera) that Attack Lucerne," by J. W. Evans, D.Sc., was communicated by J. Harold Smith, M.Sc.

Members of the Science Students' Association of the University reported on the work of their expedition to Green Island. Dr. Hill, in introducing the reports, said that this year two new investigations were made, a half-flood tide survey and bottom dredging, in addition to the activities continuing the work of the earlier Moreton Bay expedition. The students' researches had been enthusiastically continued since the return. Mr. D. Page Hanify discussed the half-flood tide map of Waterloo Bay and the Boat Passage, and in the unavoidable absence of Mr. E. F. Riek, Dr. Hill described the results of the bottom sampling, and said that Mr. Riek had determined fifty species of foraminifera from the deposits. Mr. S. T. Blake, M.Sc., described the plant ecology, and Mr. I. S. R. Munro the shore line and channel ecology and the plankton. Miss K. Watson, B.A., discussed the crabs collected. Mr. L. C. Ball and Mr. R. K. McPherson congratulated the students on the amount and quality of their work, and the Chairman expressed to all speakers the thanks of the meeting for the evening's presentations.

Abstract of Proceedings, 24th June, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 24th June, with the Acting President, Mr. H. A. Longman, in the chair. About thirty members were present. Mr. Longman announced that leave of absence for the remainder of the year had been granted to the President, Dr. F. W. Whitehouse, who had enlisted in the A.I.F. Mr. R. Newton Langdon, B.Agr.Sc., and Miss Dawn Tabrett, B.Sc., were proposed as Ordinary Members.

Dr. F. H. S. Roberts gave a brief account of the buffalo fly in Queensland. Its life history, economic importance, and distribution were dealt with. Particular attention was given to the fluctuation in the extent of the area infested by the fly year by year since it first crossed the State border from the Northern Territory in 1928. This fluctuation was shown to be associated with rainfall. Until 1939 the spread of the fly in an easterly direction had apparently been held up by a belt of dry country between Burketown and Normanton. This area was crossed during a favourable season in 1939, and in 1940 the fly occupied a very extensive area to a little beyond Normanton.

Mr. S. B. Watkins exhibited calcium carbonate minerals collected from the road cutting through basalt immediately below Cunningham's Gap. A large mass of aragonite showed the typical acicular nature of the crystals. A flat piece of calcite exhibited clusters of acute rhombohedra, whilst a rosette of calcite was of especial interest owing to its rare occurrence. Dr. E. O. Marks exhibited lignite from the bank of Cedar Creek, below Curtis Falls, at the north end of Tambourine Mountain, probably from between the basalts; and charred wood, including dicotyledonous stems or roots from the cliff face, half a mile east of St. Bernards, Tambourine Mountain, in contact with the under surface of the basalt. Miss Hill demonstrated the map of Antarctica prepared by the Commonwealth Government.

Mr. C. T. White exhibited specimens of *Lotus australis* Andr. and *Lotus coccineus* Schlecht. from the Darling Downs and Maranoa districts, Queensland. Both species were cyanogenetic; the latter had by some botanists been included as a variety of *Lotus australis*, the commonest species in Australia, but in Mr. White's opinion was worthy of rank as a distinct species. Mr. S. T. Blake showed specimens of five grasses new to Queensland—namely, *Eleusine tristachya* Lam., *Eriachne tuberculata* Domin., *E. pulchella* Domin., *E. Isingiana* J. M. Black, and *Aristida biglandulosa* J. M. Black. Mr. L. S. Smith exhibited two specimens collected by Dr. H. I. Jensen at Lawn Hill, approximately half-way between Burketown and Camooweal. One, *Triumfetta plumigera* F. Muell., was a new record for Queensland, having previously only been found in Northern Territory and North-Western Australia. The other, *Trachymene glandulosa* Benth., was not previously represented in the Queensland Herbarium, although the type specimen was collected by F. Mueller from the Nicholson River, near Burketown.

Mr. H. A. Longman exhibited an unusually large mottled stargazer, *Ichthyscopus Lebeck* (over 18 inches), and made remarks on the anatomy of the Uranoscopidæ.

Dr. D. A. Herbert moved a vote of thanks to the exhibitors, which was carried by acclamation.

Abstract of Proceedings, 29th July, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 29th July, with the President (Dr. F. W. Whitehouse) in the chair. About forty members were present. The President welcomed Mr. Gregory Mathews, the visiting ornithologist. Mr. R. N. Langdon, B.Sc.Agr., and Miss Dawn Tabrett, B.Sc., were unanimously elected Ordinary Members of the Society, and Mr. F. Chippendale, M.Sc.Agr., Miss M. I. R. Scott, M.Sc., and Mr. R. S. Boys, L.D.S., were proposed for Ordinary Membership. A symposium on poisonous plants was then held.

In opening the subject Professor Seddon pointed out that poisoning of stock was due to the Australian flora including most of the families that contain poisonous plants; the relatively greater number of toxic plants in the tropical regions; the transfer of stock to unfamiliar vegetation; and hungry travelling stock eating vegetation which ordinarily they would not touch. Many poison plants have been introduced accidentally, and some are actually fodder crops. These latter may be harmful only at a certain period of growth. The effects are variable. Some are toxic after only a single feed, whilst others are cumulative. The poisons of some plants affect the brain and higher centres, others the digestive organs, others locomotion, and others again the skin. There is a Poison Plants Committee of the Department of Agriculture and Stock and the University of Queensland doing good work in investigating what plants are harmful and what antidotal treatment can be recommended.

Mr. C. T. White stated that the poisonous plants are distributed through practically all the large families, but certain families contain a preponderance of poisonous plants, all members of which must be looked on with suspicion until proved harmless. Such are the Asclepiadaceae (cotton bushes or milky cotton), Euphorbiaceae

(spurges), and Solanaceae (potato bushes). Some families have marked physiological effects, which have not been investigated chemically —*e.g.*, various members of the Labiateae and Malvaceae, which cause shivers or staggers in travelling or working stock. In some families, there is a preponderance of cyanogenetic glucosides, particularly the Passifloraceae (passion flowers), certain Chenopodiaceae (or goosefoots), Proteaceae, and certain tribes of grasses (particularly the Chlorideae and Andropogoneae); in others there is a preponderance of plants with poisonous alkaloids, especially the Leguminosae and Solanaceae. There are marked local differences in properties of the same plants. Caltrops or "Bull Head" (*Tribulus*) in South Africa is regarded as a most serious poisonous plant. In Australia, it is not definitely known to cause trouble. Two Labiates (*Stachys* and *Lamium*) cause shivers or staggers in working stock in Australia; though in Europe and America, they are looked upon as perfectly harmless. The same species frequently vary in properties in the one country. For example, the widespread White Wood (*Atalaya*), had been proved by Ewart and Murnane to be the cause of "Walkabout Disease" of horses in tropical Australia. In the more temperate parts of Australia, the same plant seems harmless. *Lantana Camara* is comparatively atoxic in southern Queensland and New South Wales; and the variety *crocea* is known to be the cause of "pink-nose" in cattle. This has been borne out by feeding tests at Glenfield, New South Wales, and at Yeerongpilly, Southern Queensland. At the Animal Health Station, Oonoonba, North Queensland, the opposite was found to be the case. A brief survey of poisonous plants of Queensland was made according to families.

Dr. J. V. Legg discussed the effects of plant poisoning. A plant such as the common *Lantana*, which grows along the whole of the coast, causes poisoning among bullocks brought to the coast for killing. These animals are often placed in paddocks with little grass but much lantana. Carcases of animals otherwise good are unsightly because of the intense jaundice caused by eating this plant. *Hoya* poisoning is common in cattle and sheep which are driven along stock routes where it occurs. Salvia or wild mint poisoning also is common in travelling bullocks. It causes death through its high nitrate content, a factor likely to vary with the season. Soda bush (*Threlkeldia*) so common in the western sheep country was not suspected until recently. It is now known to have caused heavy mortality in sheep in the Longreach and Ilfracombe districts. Sheep rarely eat the plant ordinarily, but when starved they will devour it. A peculiar effect is the sitting-up attitude of the dead sheep. Poison peach (*Trema*) common on the coast is very poisonous for cattle and sheep. It is not due to prussic acid as first thought, but to something yet unknown. *Verbesina* and *Wedelia* (two sunflowers) are toxic when eaten in large quantities by hungry stock. They produce pneumonia. *Brachyachne* (one of the couch grasses) has caused heavy losses in the St. George district recently. Death is rapid, due to the prussic acid content. In both *Swansonia* (indigo) and *Atalaya* (white-wood) the poison is cumulative and the animal is not affected for several weeks. With the indigo plants the animals develop a craving and will eat nothing else.

Mr. H. J. G. Hines pointed out that the desirable procedure with poison plants was to discover the nature, the poisonous principle, the amount present, the lethal dose, and the mode of action on animals likely to graze upon it. As a matter of routine the plant is examined for cyanogenetic glucosides and for alkaloids. These, if present, may

or may not be recognisable. Further investigation is usually done by fractionating the plant constituents by using various solvents and by testing soluble and insoluble fractions for their toxicity. The chemical examination is assisted by pharmacological observation. The effect on the animal should be noted system by system. In this way clues to the toxic principle can be obtained before pure substances can be isolated by chemical methods. For example, drugs affecting the cardio-vascular system may act directly upon the heart, upon the vessels, or on the blood itself. *Asclepias curass,* for instance, has an action on the heart closely resembling that of strophanthin. The toxic principle has not yet been isolated in a pure state. Several plants, such as *Salvia reflexa,* contain sufficient nitrate to convert a large proportion of the haemoglobin to methaemoglobin. There is evidence that grazing animals can develop a tolerance towards some poisons, enabling them to consume more than the toxic amount without lethal effect. This aspect is receiving further study.

Mr. E. H. Gurney mentioned that some plants contain the very toxic hydrocyanic acid (prussic acid) as cyanogenetic glucosides. These include some common fodders and also plants consumed only in times of scarcity. It is thus important to know the quantities and distribution of the poisonous glucosides in plants. Sorghums require to be fed to stock with care, for indiscriminate grazing on immature sorghum has caused frequent mortalities. It may be generally accepted that the young plant contains more hydrocyanic acid than when mature. Investigations in America have demonstrated that the sorghum leaves may contain three to twenty-five times as much hydrocyanic acid as that contained in the stalk. Hydrocyanic acid in the form of a glucoside when acted upon by a suitable enzyme is decomposed and the poisonous substance set free. Suitable enzymes are usually present in the plants containing cyanogenetic glucosides, but even if these enzymes are not present or only in insufficient amount it is quite possible that other foods eaten by the stock will supply enzymes. *Sorghum verticilliflorum,* which grows wild on headlands and roadsides, has been analysed in the laboratory of the Department of Agriculture and Stock and found at times to have at different stages of growth toxic amounts of hydrocyanic acid present. Plants such as *Eromophila maculata, Ximenia americana,* and others have been found to contain exceedingly high amounts of hydrocyanic acid, and the extent of effect of these when consumed by stock depends upon a number of factors.

Messrs. Gipps, Blake, Hirschfeld, Schindler, Ball, and White took part in the discussion which followed, and a vote of thanks, proposed by Messrs. Barker and Ogilvie, was carried by acclamation.

Abstract of Proceedings, 26th August, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 26th August, with the President (Dr. F. W. Whitehouse) in the chair. About fifty members and visitors were present. The minutes of the previous meeting were read and confirmed. Mr. F. Chippendale, B.Sc.Agr., Miss M. I. Scott, M.Sc., and Mr. R. S. Boys, L.D.S., were unanimously elected Ordinary Members of the Society. Arthur Wade, D.Sc., A.I.C.S,. was proposed for Ordinary Membership.

Dr. D. A. Herbert exhibited specimens of *Calendula officinalis* (English marigold), *Bellis perennis* (English daisy) and *Senecio*

cruentis (cineraria) bearing æcidia nine days after inoculation with æcidiospores of the rust fungus *Puccinia distincta.* These and other inoculation experiments, together with the fact that *Puccinia calendulæ, P. distincta,* and *P. cinerariæ* described by McAlpine from the hosts mentioned are identical, show that the three rusts must be included under *Puccinia distincta* McAlp.

The following papers were read:—

(1) "Aphididæ in Australia, Part II.," by G. H. Hardy.

(2) "The Geology of the Antarctic Continent and its Relationship to Neighbouring Land Areas," by A. Wade, D.Sc., A.I.C.S. The geological results of the various Antarctic expeditions were summarised, and comparisions were made with the geological sequence and structure of the adjacent continents. These matters were reviewed in the light of various theories of continental drift.

Mr. C. T. White, Mr. L. C. Ball, Prof. H. C. Richards, and Dr. W. H. Bryan took part in the discussion which followed.

ABSTRACT OF PROCEEDINGS, 30TH SEPTEMBER, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 30th September, with Professor H. C. Richards in the chair. About thirty members were present. The minutes of the previous meeting were read and confirmed. Arthur Wade, D.Sc., A.I.C.S., was elected into Ordinary Membership, and Mr. J. Hanson Lowe, B.Sc., was proposed for Ordinary Membership. The chairman announced that the rearrangement of the Library was now complete.

Mr. L. C. Ball (Chief Government Geologist) exhibited, with the permission of the Minister for Mines (the Hon. D. A. Gledson), specimens and photographs illustrating his recent discovery of bauxite on Tambourine Mountain. Mr. S. T. Blake exhibited specimens of *Cyperus cuspidatus* H.B.K. from near Ipswich, a relatively rare species; *Schoenus scabripes* Benth. from Stradbroke I., previously known only from the type collection from Moreton I.; *Plectrachne Schinzii* Henr. and *Triodia Basedowii* Pritz., two grasses not previously formally recorded from Queensland. Mr. L. Herdsman exhibited chalcedony simulating prismatic quartz crystals up to half an inch wide, and four inches long, from the basalt of the Darlington Range. Dr. Marks, Dr. Bryan, Mr. Ball, and Mr. Gipps commented on the exhibits.

Dr. W. H. Bryan read his paper "Spherulites and Allied Structures, Part I." The many and varied spherulitic forms were described and classified, as were the corresponding internal structures. The conditions under which spherulites are produced was considered, especial consideration being given to radial and concentric growths, in reference to which other natural and artificial structures closely resembling spherulites proper were examined. The speaker's researches were illustrated by a large and representative collection of spherulites from south-eastern Queensland.

Dr. Wade, Mr. Ball, Mr. Gipps, Dr. Hill, Dr. Herbert, and Professor Richards joined in the discussion on the paper, and the meeting showed its appreciation by acclamation.

Abstract of Proceedings, 28th October, 1940.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 28th October, with the Vice-President (Prof. H. R. Seddon) in the chair. Twenty-five members and friends were present. Mr. J. Hanson-Lowe, B.Sc., was elected into Ordinary Membership.

The main business was an address on "Diet in Relation to Drought."

Mr. J. M. Harvey, in the absence of Dr. White, outlined the main problems of drought feeding, and showed how research workers were approaching these problems.

He stressed the necessity of supplementing the dry grass with protein-rich foods. This additional protein in the diet of the ruminant enabled the animal to make better use of the dry grass by increasing its digestibility. When the standing hay had so deteriorated that its energy value to the sheep was less than the energy expended in mastication and digestion, some carbohydrate concentrate should be fed. In practice better results are obtained by feeding the concentrates in meal form, for intimate mixing makes selective feeding impossible. Meal feeding means trough feeding, but the advantages of trough feeding over "broadcast" or "scatter" feeding far outweigh the additional cost of troughing.

It is important to note that when insufficient roughage to ensure rumination is available, whole grain should not be fed as it is largely undigested and deaths, particularly with lambs, may be heavy. In the complete absence of roughage sheep can be kept alive satisfactorily on concentrates only. Rumination is completely suppressed so that care should be exercised at the end of the feeding period to re-educate the sheep in rumination. This system of feeding is not to be employed with lambs because of the danger arising from an under-developed rumen.

Mr. C. T. White spoke on edible trees and shrubs and their value in droughts. His remarks were illustrated by a large series of mounted specimens of natural and imported trees.

Mr. K. Kesteven explained that the biological value of the protein in individual foods may be markedly increased by mixing with other sources of protein. Assuming that in mixtures the total protein was of the same biological value, he showed by charts and calculations how to arrive at the most economical buying per unit of food.

Mr. Gray, Dr. Herbert, and Mr. Gipps also took part in the discussion, and a vote of thanks to the speakers was moved by Mr. Gurney, seconded by Mr. Perkins, and carried by acclamation.

Abstract of Proceedings, 25th November, 1940.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University on Monday, 25th November,

at 8 p.m., with Professor H. R. Seddon in the chair. Apologies for absence were received from Drs. F. W. Whitehouse, D. Hill, and A. J. Turner.

Mr. R. F. Langdon, B.Agr.Sc., exhibited specimens and photomicrographs of *Claviceps pusilla,* the fungus responsible for ergot of Queensland Blue Grass (*Dicanthium sericeum*). This fungus has not previously been recorded from Australia.

Dr. D. A. Herbert exhibited specimens of dahlia affected by the yellow ringspot virus at present classified as Dahlia Virus 2A. This disease appeared on seedling dahlias in 1939.

The following papers were read:—

(1) "Notes on Australian Cyperaceae V.," by S. T. Blake, M.Sc.

(2) "The Vegetation of the Lower Stanley River Basin," by S. T. Blake, M.Sc.

(3) "Spherulitic Crystallization as a Mechanism of Skeletal Growth in the Hexacorals," by W. H. Bryan, M.C., D.Sc., and Dorothy Hill, M.Sc., Ph.D.

(4) "Latent Infection in Tropical Fruits and the Part Played by the Genus Gloeosporium," by J. H. Simmonds, M.Sc.

(5) "Preliminary Note on Photosensitization of Sheep Grazed on *Brachiaria brizantha,*" by N. W. Briton, B.V.Sc., and T. B. Paltridge, B.Sc.

A paper by A. J. Turner, M.D., F.R.E.S., entitled "Fragmenta Lepidopterologica," was laid on the table.

The following Institutions, Societies, etc., are on our exchange list, and publications are hereby gratefully acknowledged. Owing to war conditions, many of our exchanges have temporarily lapsed.

ARGENTINE—
Universidad Nacional de la Plata.
Universidad de Buenos Aires.

AUSTRALIA—
Commonwealth Bureau of Census and Statistics, Canberra.
Department of Agriculture, Melbourne.
Department of Mines, Melbourne.
Royal Society of Victoria.
Field Naturalists' Club, Melbourne.
Council for Scientific and Industrial Research, Melbourne.
Australian Chemical Institute, Melbourne.
Department of Mines, Adelaide.
Waite Agricultural Research Institute, Glen Osmond.
Royal Society of South Australia.
Royal Geographical Society of Australasia, Adelaide.
Public Library, Museum and Art Gallery, Adelaide.
University of Adelaide.
Standards Association of Australia, Sydney.
Naturalists' Society of New South Wales.
Department of Agriculture, Sydney.
Department of Mines, Sydney.
Royal Society of New South Wales.
Linnean Society of New South Wales.
Australian Museum, Sydney.
Public Library, Sydney.
University of Sydney.
Botanic Gardens, Sydney.
Australian Veterinary Society, Sydney.
Queensland Naturalists' Club, Brisbane.
Department of Mines, Brisbane.
Queensland Museum, Brisbane.
Department of Agriculture, Brisbane.
Royal Geographical Society of Australasia (Queensland), Brisbane.
Royal Society of Tasmania.
Mines Department, Hobart.
Mines Department, Perth
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Presidential Address:

THE SURFACE OF WESTERN QUEENSLAND.

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(Six Text Figures.)

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Western Queensland—conventionally that portion of the State west of that "Great Divide" that separates the east coast waters from those of other systems—essentially is a land of flat-lying sediments and of great plains. Three minor areas within it are of rugged country with folded rocks; but it is with the flat lands of the region, particularly those west of a line from Normanton to Brisbane, that I am concerned to-night. The drainage forms of those great plains have curious features never adequately described and seemingly unlike those recorded from other countries. Incidentally, because of this novelty, peculiar problems arise in conserving the western waters.

THE GEOLOGICAL FRAMEWORK.

Most of Western Queensland is occupied by Mesozoic sediments of the Great Artesian Basin. This basin, widening southwards, is flask-shaped. Flanking its bottle-neck are folded and intruded rocks of Pre-Cambrian age. Adjacent to them in the west are Lower Palaeozoic sediments, chiefly Cambrian limestones, that still are undisturbed, having dips usually of the order of 50 feet per mile. In the easterly Pre-Cambrian belt folded Lower Palaeozoic rocks occur. A small area of Palaeozoic rocks occurs also in the extreme south-east.

The Mesozoic cover to the Great Artesian Basin is an enormous area of Cretaceous shales and calcareous sandstones. In the higher lands of the Great Divide Lower Mesozoic sediments outcrop from below this Cretaceous cover, some of them forming the intake beds to the basin. These earlier Mesozoic beds are an alternating group of impervious calcareous sediments (shales and sandstones) and porous sandstones. Unconformably upon the Mesozoic surface are early Cainozoic beds in the south-west and occasional remnants of late Cainozoic beds in the east. With the exception of the earlier portion of the Cretaceous sequence all post-Palaeozoic sediments are non-marine.

In Pliocene times, as has been shown,* these various surface outcrops were converted to laterite soils, the laterite mantle being

* An account of the lateritic soils of Western Queensland lately has been published (Whitehouse, 1940, 1) to which reference should be made for details. Conclusions reached from a study of this cover are stated throughout this address without further explanation.

continuous over the whole of Western Queensland except in the dissected lands of the Pre-Cambrian ranges and possibly in some of the higher country of the Great Divide. Two periods of laterite formation in the Pliocene have been demonstrated. After some measure of denudation of the laterites had taken place basalt was poured out in the region of the Great Divide, extending west of it in three regions—between the parallels of 18° and 21°; 24° and 27°; and 26° and 29° S.

The latest deposits of the region are a series of alluvia and other transported soils, ranging in age from early Pleistocene to the present. Outstanding among these are the older alluvia, between the lateritic remnants, and the great sand dunes of the Simpson Desert in the south-west.

THE GREAT DIVIDE.

The Great Divide has a sinuous but rather regular course, occurring relatively close to the coast in the north and in the south and progressively receding from it in Central Queensland. In position there is a complementary agreement with the edge of the continental shelf as Bryan (1928) has noted and discussed.

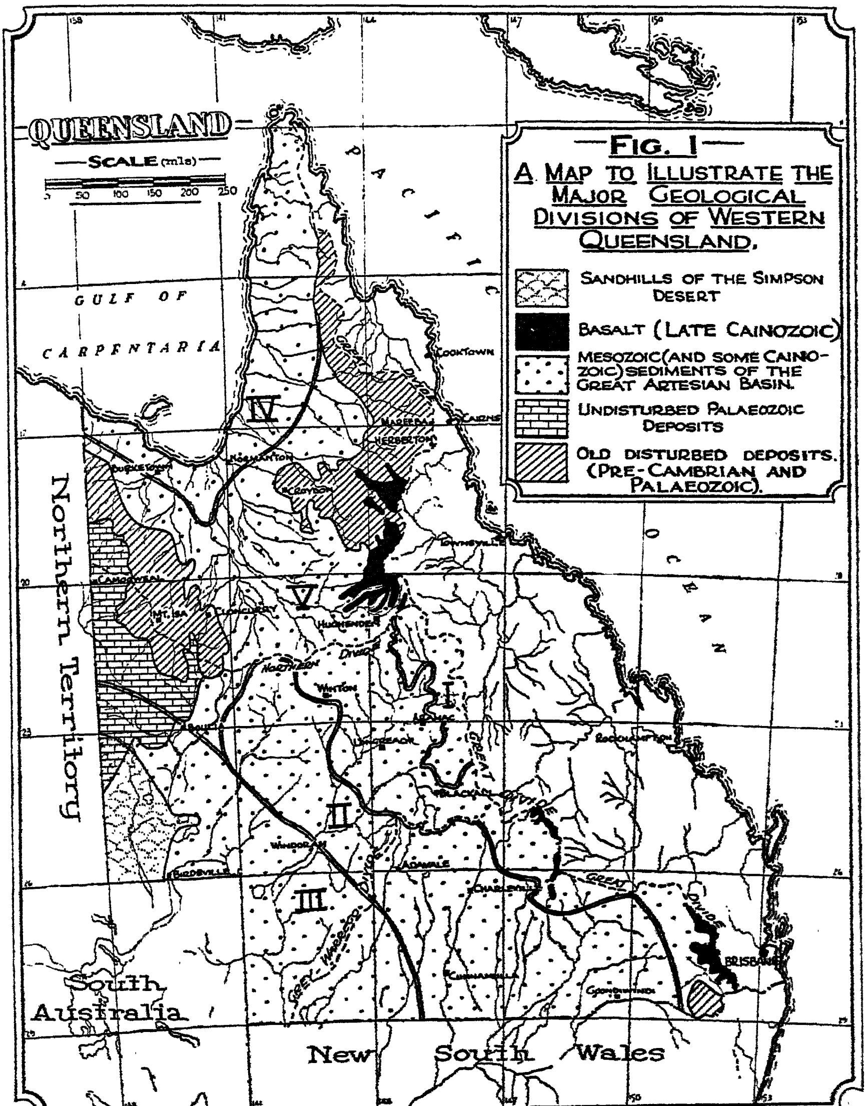
There may be some agreement of the divide with structural features in the north-eastern belt of Pre-Cambrian and Palaeozoic rocks, but I have no personal acquaintance with that region. Elsewhere it is usually an insignificant thing, avoiding the most striking, true mountain masses (of Palaeozoic rocks) such as the Bellenden Ker and Drummond Ranges. At its best, in the basaltic areas, it is an eastern scarp, often quite impressive, from a very gently sloping western surface. But in most places the gradient on either side is very slight, there is no elevated structure to mark its position and the casual traveller crosses it without being aware that he has passed over a divide. There is but one region where it forms an imposing, two-sided ridge—in the basaltic horst of the Bunya Mountains. The absurdity of labelling the whole long line the "Great Dividing Range," as is the custom on our maps, has been stressed by many writers.

Griffith Taylor (1911, p. 9) has suggested that formerly the main divide was in the zone of the granitic masses near the coast and that relatively recently it has migrated towards the line of major basaltic effusions. Much of this reasoning was based on suggested river captures. There is, however, good reason to believe that the Great Divide was not far from its present position just before the basalts were outpoured.

From latitude 21° southwards, apart from the region of the basalt plateaux, the natural position of the Great Divide is the imposing scarp, reversed to the direction of dip, of the Bundamba Sandstones (early Jurassic). That scarp is a wall-like feature, particularly between latitudes 24° and 26° S., where there are few passes through it. Sometimes, as at the head of the Nogoa River, the divide does coincide with it; but usually it is some distance away, the scarp being equally prominent whether it is part of the Great Divide or not. From that scarp the divide wanders over later Mesozoic formations, sometimes even on the territory of the Walloon Series (late Jurassic) which in general forms a relatively depressed area.

In the region of the Mesozoic formations the height of the divide is never much more than 1,500 feet above sea level. Repeatedly in its neighbourhood, and sometimes agreeing in position, there are laterite

residuals. Only when there is such a direct agreement is there any visible rise in the neighbourhood. From this common association, and from the gentleness of the slopes, it is inevitable to suggest that when the great Pliocene laterite mantle was new it was a continuous sheet with a plainland surface, gently and almost imperceptibly warped across a line that was not far from the present divide; and that, by subsequent erosion and corrasion by the streams, the Great Divide has received such little emphasis as it has to-day.



THE AREAS DELIMITED BY DOUBLE LINES ARE THE NATURAL REGIONS OF LATERITIC RESIDUALS, THUS:
I. THE ALICE TABLELAND ; II. THE CENTRAL REGION
III. THE SOUTH WESTERN REGION ; IV. THE GULF REGIOI
V. THE INTER-LATERITIC REGION.

TEXT FIGURE 1.

Over the Alice Tableland* that laterite sheet virtually still is continuous, covering an area of over 20,000 square miles and presents a picture slightly modified of what the Great Divide must have been like in Pliocene times. It is the sole considerable remnant of the original divide features. This plateau, so well described by Daneš (1910), is a region from 1,000 to 1,600 feet above sea level, with gentle drainage on its surface to east and west. But along its axis, in a very slight depression of the Walloon Series, there are basins of inland drainage that are discussed later in this address. That is, the slope either way is so gentle that the divide is most difficult to define on the monotonous plain. However, towards the eastern edge of this plateau, erosion partially has uncovered the scarp of the Bundamba Sandstone and the Great Divide is tending to become coincident with it—it does coincide over part of the region, but not west of Natal Downs.

Later geological events have modified slightly the position of the divide. Most important of these was the outpouring of the basalts. I have been able to show (Whitehouse 1940, pp. 57 and 58) that two of the great basaltic effusions were later than the laterites. Work now in progress suggests that the third and southernmost flows of basalt also were contemporaneous. All three basaltic areas are now dissected, the highest points in each region being of the order of 4,000 feet above sea level.† Since the basalts are later than the laterites their presence must have modified locally to some degree the position of the divide, as defined by the warped laterite surface and its subsequent dissection.

A later and most curious modification occurred about latitude 26° 30′ S. in a basin 200 square miles in area and 120 miles from the coast. Here, later than the laterites and also than the basalts which they cover, is a series of clays and silts of Pleistocene age. They form a continuous sheet between Burraburri Creek (of the western waters) and the Boyne River (of the eastern group), the alluvial plain of each stream touching the edge of the deposit. Nowhere is the height more than 60 feet above either watercourse. The surface is a monotonously flat, black soil plain not marked by much gullying and it is impossible, without detailed levelling, to define where upon it is the line to mark the divide. Alone of all sections in Queensland the State 2-mile maps delete the term "Great Dividing Range" across these plains, though the name appears on the 16-mile sheets. Here the idea of a "range" has its greatest absurdity. Here, too, the present surface run-off, which is sheet drainage rather than gullying, must be similar to what it was across the laterite divide in Pliocene times—that is, the Pliocene type of divide here has been reconstructed on a minor scale and at a lower level.

FORMER PLAINS.

Over the vast expanse that they cover in Western Queensland the Mesozoic sediments are almost horizontal. Dips generally are less than 40 feet per mile. The rocks in the Cambrian limestone belt in the furthest west similarly are most gently disposed. It reasonably follows that, except for the rugged lands in the Pre-Cambrian sectors, this

* The name Alice Tableland hardly ever has appeared in literature. On the maps it is shown on what is part of the laterite plateau east of Aramac. It has been there since 1866. A name is needed for the whole of this tableland (as delimited on Figure 1) and the name Alice Tableland here is used in that sense.

† Other high masses in Queensland, in non-basaltic areas, reach this figure which may have more than passing significance.

region has been one of great plains continuously almost since the close of Mesozoic sedimentation. There have been, however, some vicissitudes during pluvial periods in its otherwise monotonous history, chiefly with the deposition of Tertiary fluviatile sediments and by the formation and the dissection of laterite soils towards the close of the Tertiary era. The production of the first laterites, although they changed the composition of surface material, probably did little to disturb the form of the pre-existing plains. More likely they intensified the plainness. But there followed, later in the Pliocene, a period of erosion and then a recurrence of lateritic conditions that must have modified to some extent, though possibly slightly, the earlier drainage patterns.

THE PRESENT PLAINS.

The existing plains for the most part are at a lower level than the laterites, which now remain as remnants of the former surface. In most regions they are of late (post-Tertiary) deposits, properly obscuring the Mesozoic sediments beneath, with the laterities fringing them as marginal tablelands of similar height or scattered between the water-courses as mesas and buttes (see fig. 4). Commonly in such regions the deposits of the plains are composed, in some part, of lateritic detritus, either as little-adulterated material stripped from the ridges or else as ingredients in the various alluvia. Most striking of these latter is in the South-Western Region (as delimited on fig. 1) where a very old, red, alluvial deposit is widespread within which, subsequently, thick lime pans have formed. There is little reference to this very extensive deposit in Queensland literature; but laterally it is continuous with similar material in New South Wales, South Australia and the Northern Territory, where it has been described by David (1914, p. 608 f.) under the heading "The Red Soil Plains of the Western District" and by Ward (1927, p. 12) without any special name. Other old alluvial deposits, containing Pleistocene mammalian bones, are greyish-brown silts like the now-forming alluvium, though often more cemented by lime.

Over a large territory comprising much of the basins of the Georgina, Thompson and Barcoo Rivers, and of the streams that flow to the Gulf of Carpentaria (that is, the Inter-Lateritic Region of fig. 1), the dismembering of the laterites is practically complete. Lateritic residuals are very few. Often nothing is left but "gibbers" (massed nodules of the siliceous zone) upon a few divides. In this region erosion of the older alluvia is more advanced and the pre-Tertiary sediments, Cambrian or Cretaceous, commonly are exposed. But even these, being almost horizontal and easily eroded (limestones and shales mostly), give rise to plains with pedocalcic soils very similar to and often in the mass indistinguishable from the silts of the river flats. Such are the true "Rolling Downs" of Western Queensland, a typical savannah land. They sweep across the north-central portion of the State within the Inter-Lateritic Region; and coming west of Boulia pass northwards through the Georgina Valley to the Barkly "Tableland," a downs area nestling in a great curve of the Pre-Cambrian ranges.

In the South-Western Region the erosion of the laterites also is far advanced, for the laterite residuals are only of the lowest zones in the profile. But here, more particularly in its western portion, arenaceous Tertiary beds (the Eyrian Series) often cover the Marine Cretaceous shales. The remants of these, dissected by the rivers,

remain as mesas, buttes and ridges similar to those of the laterites, and the true plains are at yet a lower level—presumably, although the older alluvia obscure the evidence, about the top of the Cretaceous shales.

Thus the plainlands of Western Queensland (the vast "downs" and the old alluvial plains) have been formed by the gradual dissection of a previous level surface—the laterite plain. In one great region this process is now complete and the laterites are gone. In another the laterites are mainly removed but other residuals are present. In the latter, as in the regions where laterites largely remain, the process is still in progress and great sheets of late sediments form very level country between the residuals. Two suggestions may now be advanced—that the process was more rapid in Pleistocene times and now virtually is arrested; and that the action was further accelerated in the more advanced regions by slight, localised, orogenic movements.

The great sheets of old alluvia remote from present watercourses testify to greater depositive powers of the rivers in the past and, correlatively, to considerable erosion in such pluvial times. Collateral evidence of this is given by the great valleys and gorges of many small streams east of the Great Divide. With the present meagre rainfall in Western Queensland the progressive erosion of the laterite remnants now must be relatively slight. Some confirmation of this, as noted below, is given by the Upper Diamantina where the streams, in the broad, inter-lateritic valleys, have mature, well-braided courses.

The main drainage lines of Western Queensland converge towards Lake Eyre in South Australia. Two large drainage systems, however, depart from these. In the south-east the streams lead to the Darling River in New South Wales, and an outlet to the Southern Ocean. In the north the rivers flow to the Gulf of Carpentaria. If there was any orogenic factor in the deflection of the south-easterly system it was no doubt slight and is referred to below as a possible sag in the Warrego basin. The difference in direction possibly was impressed upon the old laterite surface; for the divide is a semi-continuous ridgeland of laterite, the Grey and Warrego Ranges, left as a normal dividing upland.

But some other explanation seems desirable for the deflection of waters northwards. About the 21° parallel of latitude there is a marked change not only in surface drainage but also in the sub-surface. The Great Artesian Basin is markedly divisible into two parts in this region, the isopotential lines diverging from such a zone. David (1911, p. 48), Jensen (1920, p. 30) and others have drawn attention to the presence of a buried ridge of old rocks in this region. Since this is the axis of the area from which the laterites have been completely stripped, it is now suggested that relatively recently (? in the Pleistocene) there was a slight uplift along this axis allowing locally a greater erosion to take place.

It is possible, though I do not wish to stress this matter, that at the same time there was a slight depression in the Lake Eyre basin in South Australia, allowing, by accelerated erosion in the adjoining areas, the laterites to be more completely stripped in the South-Western Region than in the adjacent but more remote Central Region.

The plains themselves are remarkably level; and when as occasionally happens, for instance between the Flinders and the Saxby Rivers,

they are treeless and remote from laterite residuals, the perfectly level horizon bounding only grassy plains to all points of the compass is a most memorable sight.

THE RIVERS.

The rivers of Western Queensland are intermittent streams. Only the Gregory, fed by copious though declining springs from the Cambrian limestones, flows perennially. The remainder, except for an occasional winter flow, are active only in the summer monsoonal season. In times of very heavy rainfall at their heads the summer floods of the more westerly streams spread enormously. There are places towards the South Australian border (between Betoota and Birdsville, and south of Windorah) where then the waters of the Cooper and the Diamantina spread laterally 30 to 50 miles or more; while further on, across the border below Innamincka, it is said that in full flood the Cooper may be 90 miles wide.

Flowing over the great, silty plains these rivers have the features of flood plain rivers but on a grander scale than is recorded elsewhere. In flood plains of moderate width a river frequently develops a braided form. It divides into a few sub-parallel courses that here and there connect. Such, but greatly more wide-spreading, are the braids of Western Queensland, the braids of the streams increasing in intensity westward to reach their acme in those of the Georgina system. They are so intricate, so more widely imbricating, that really they deserve another name. Curiously enough ox-bow lakes, characteristic features of small flood plains, are rare in these regions due to the rareness of ordinary meanders. Instead the removed waterholes of a stream are long and relatively straight billabongs.

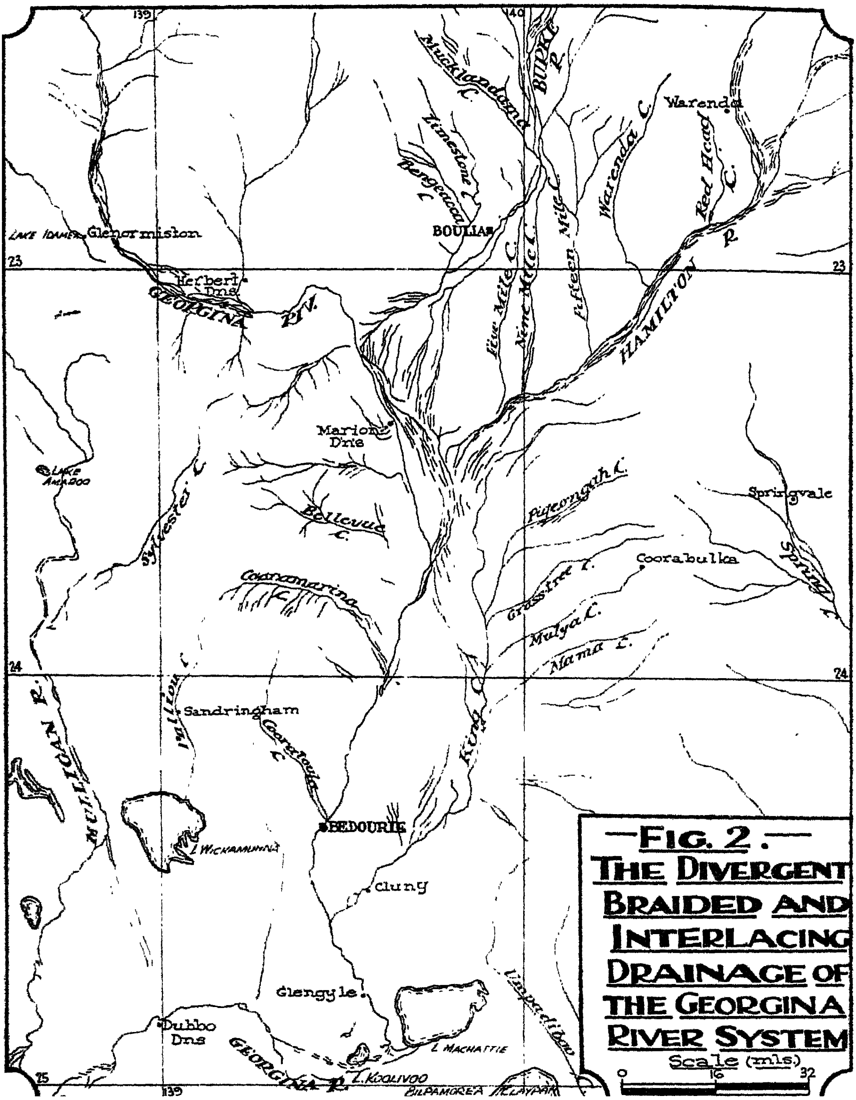
On large, normal deltas a stream commonly distributes its waters into several, progressively diverging channels, producing what has been termed the "bird's-foot" type. These, sometimes large but far removed from the river mouths, also are recurrent types in Western Queensland. Occasionally the divergent branches, and more rarely the channels of a braid, deploy around lateritic remnants.

Such is the general flatness that commonly a distributary from one stream joins another river system. Beames Brook, for example, leaves the Gregory and joins the Albert, both branches, below the point of departure, flowing permanently. In times of flood Spear Creek unites the Saxby and the Norman Rivers. Other examples are mentioned in the three selected river systems described below. This latter feature together with the large-scale interlacing of watercourses is perhaps more pronounced in the adjacent regions of New South Wales.

1. *The Georgina River* (fig. 2): The Georgina River rises in the Northern Territory, flows into Queensland and takes a southerly course modified by an easterly reach about latitude 23° S. After resuming its southerly direction it receives the channels of the Burke and, a little lower down, of the Hamilton. In this junction region there is an amazing tangle of channels. Some of these are shown in fig. 2; but the region is not fully surveyed and the existing maps, as also those of the other regions figured below, show only a selection of the maze of watercourses.

The Burke, in its lower reaches, is not markedly braided, having a main bed and only a few minor channels. But from 50 miles above

the junction distributaries leave the Burke, as Fifteen Mile, Nine Mile and Five Mile Creeks, and join the Hamilton. A few lateritic residuals are present in this divergent region.

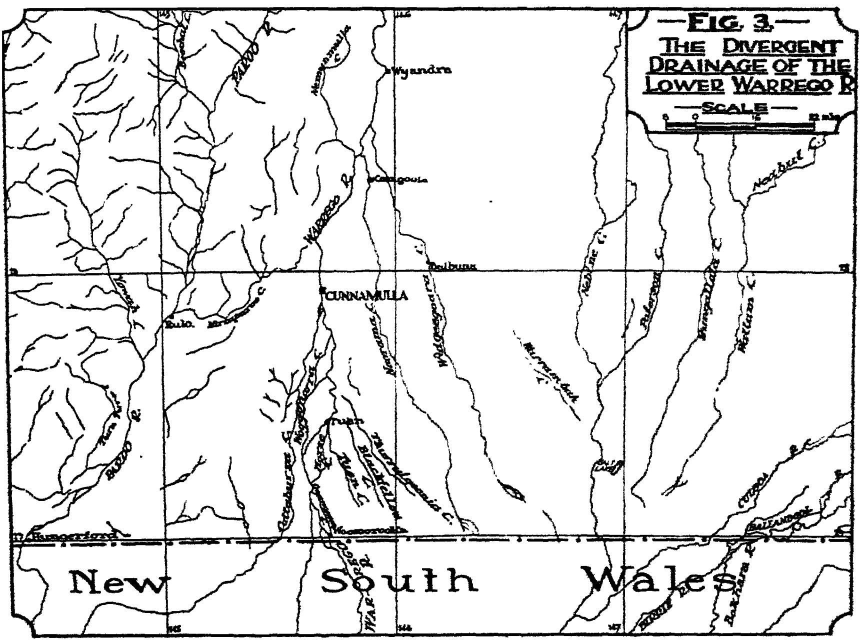


TEXT FIGURE 2.

The Hamilton approaches as a perfect braid. Where the main road from Winton to Boulia crosses there are between forty and fifty channels in a distance of 3 miles. The width of this zone varies as does the intensity of the courses. As it nears the Georgina that river has a channelled zone some 8 miles wide, with the main channel on the western side. The braid of the Hamilton is added to the minor channels on the east, whereupon the full width of the braided area is some 16 to 20 miles. Almost immediately a number of channels become clustered

into a new braid, diverge from the main course as King Creek which, after both streams have for a time reduced their braids to virtually a single channel, rejoins the Georgina about 80 miles from where it left.

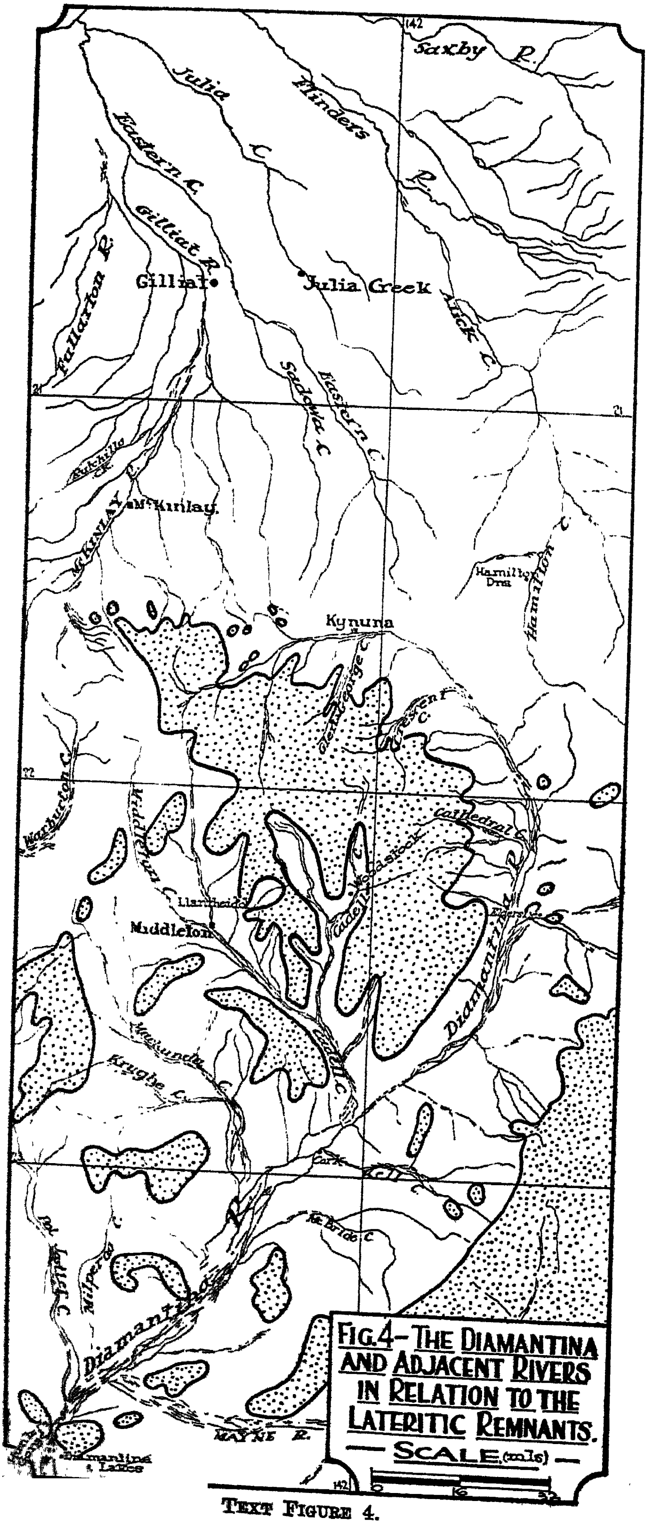
2. *The Lower Warrego* (fig. 3): The Warrego River below Wyandra is the best example in Queensland of a divergent river system. The main channel flows south between the Paroo and the Culgoa Rivers, all three streams joining the Darling in New South Wales. Below Wyandra the distributaries begin. Widgeegoara, Noorama and Thurrulgoonia Creeks leave on the eastern side and join the Culgoa and a few minor courses trend in the same direction. On the western side Mirraparoo and Cuttaburra Creeks link the Warrego with the Paroo. Other members (Woggonorra, Horse and Owangowan



Text Figure 3.

Creeks) leave the Warrego and return to it forming a broad reticulum* between Tuen and the New South Wales border. At the border the divergent zone is about 140 miles wide, while the distance to the first point of departure of the distributaries is 120 miles. It increases further south in New South Wales so that its maximum width is 160 miles and its length 200. Thus this system, so similar to the divergent watering of a delta, is larger in area than the great deltas of the Nile, the Congo, the Indus, the Irrawaddy, and the Mississippi and is exceeded only in size by the delta of the Ganges. It differs from the normal delta of a river system in that between the distributaries all is not level. Slightly higher land and even some laterite residuals occur between.

* "Reticulum" is suggested as a technical term for interlaced anabranches of this type.



TEXT FIGURE 4.

It is possible that the basin of this system is a slight tectonic depression. Flanking it on the west in the Eulo-Hungerford-Thargomindah region is an area in which the old granite-slate bedrock of the Artesian Basin rises close to the surface and, in several places, actually outcrops. Immediately east of the Warrego distributaries, as shown by data of the artesian bores, is another area of shallow bedrock (below the Neebine), although more deeply buried than the western zone. The river region between may represent some slight depression that has influenced surface activities.

3. *The Upper Diamantina* (fig. 4): The Diamantina River in its upper courses illustrates particularly well an early stage in the dissection of a laterite mass, although the streams themselves have mature features. The river rises on the largest lateritic residual west of the Alice Tableland. Shortly it descends to the plains and takes a crescentic course around the mass as far as Elderslie where it re-enters the lateritic area. To this point its larger tributaries all drain the tableland, entering on the right side. All left bank tributaries are very short. It is a good example of what has been called the "Palm-Tree" type of drainage. Four features are worthy of notice—in each of the wider swathes carved out of the laterites, in Pleistocene times, the floor is covered with old alluvium over which the watercourse, be it the main stream or a tributary, develops a braided form; the form of the watercourse changes, being usually braided but in places is reduced to a single channel; wide reticula, similar to but smaller than those noted on the Lower Warrego, are present; and, finally, the great northern divide, separating the Gulf waters, comes to within 5 miles of the main stream along the northern arc of its course.

The contrast with the adjacent Gulf rivers is striking, for they are not particularly braided. There is no definable feature separating the two systems. Viewed from the air there seems no reason why the initial Diamantina waters should not flow to the Gulf of Carpentaria; for only a mile or two away, and with nothing but a plain between, gullies make away to the northern rivers. Griffith Taylor (1911, p. 10) has postulated stream capture in this region, the original left-bank tributaries of the Diamantina now being deflected northwards. It may have happened. A similar feature, but on a smaller scale, is exhibited by the Thompson and the Darr Rivers west of Longreach. There the Darr is draining an almost base-levelled lateritic remnant and the long tributaries of the Thompson begin very close to the main channel of the Darr. Whatever be the cause the difference between the braided Diamantina and the adjacent, one-channelled northern streams in similar environment, suggests some difference in origin. Possibly the northern courses are rather later in development which would accord with stream capture (as postulated by Taylor), with late orogenic movements (as suggested above) or with a combination of the two factors.

The most striking reduction from a braid is at Diamantina Gates below the junction with the Mayne, where the river is reduced to a single channel that carves a gorge (Hunter's Gorge) about 50 feet deep through the laterites. Below this it swells again to a braid. However in times of larger flooding other channels become operative around other residuals, not all of the water going through the gorge.

Other Aspects.—A particular type of this drainage is illustrated by the Cooper below Windorah. Near the town two main channels

separate—the Cooper proper to the west and Wombunderry Channel in the east. These progressively diverge to an interval of 20 miles and rejoin at a point over 100 miles below their place of departure. Each course is flanked by minor channels and over the intervening flood plain there is an intricate, unmapped plexus of dry runnels. The feature is repeated; for Wombunderry Channel itself divides, its lesser eastern member being Goonaghooheeny Billabong that progressively diverges from the parent channel and finally joins the Cooper which meanwhile has curved more to the east. The system, however, is not radically different from those already described since it combines the essential aspects of the King Creek link from the Georgina and the divergent streams of the Warrego.

One noticeable feature of these seldom-flowing streams is the presence of long, ribbon-like waterholes sometimes on the main channel, sometimes on minor members. Such permanent natural reservoirs vary from small holes, only a few chains long, to giants 20 miles or more in length (as at Eulbertie and Retreat). Why they, as special portions of the watercourse, should be subject to the undue scour to maintain them is usually not obvious.

The braiding, reticulation and other peculiarities of these streams clearly are mature features and have been long in operation. There is evidence that some were in existence at least as early as the Pleistocene. As described elsewhere (Whitehouse, 1940, p. 50) there is a great reticulum of watercourses in the far north-west, in the basin of Lawn Hill and Widallion Creeks, precisely similar in plan to those on the plains, though there they are incised in the rugged, resistant rocks of the western Pre-Cambrian mass. Evidence has been quoted that this system arose on an old silt cover that since has been stripped, leaving the system superimposed upon the underlying rocks. When described the term *Incised Braids* was suggested for this type. *Incised Reticula* would be more appropriate.

Special circumstances are no doubt necessary to produce such a novel drainage system. With ordinary braided streams of small compass the combination exists of an alluvial foundation, slight gradient and occasional flooding. Such three factors in Western Queensland are exaggerated. The alluvial plains are of great width and very slight slope, and the streams for most of the year are dry, the seasonal flood waters inundating dry channels. No doubt to these exaggerated conditions are due the peculiarities of the streams.

The formation of large recticula by the channels reaches its maximum in the far south near the New South Wales border, with the widely spaced anabranches of the Warrego, the Condamine and the Macintyre. The intricate braiding, however, increases westwards with increasing aridity as far as the Georgina. Beyond that, in the region of greatest aridity, are only the three rivers that "flow" through the Simpson Desert—the Mulligan, the Field and the Hay, the two latter rising in the Northern Territory. All three are hemmed in by sandhills. The Mulligan flows sometimes, the Field very rarely (it is said in the west that only two white men have ever seen the Field flow into Queensland). The Hay may never have flowed since white men came to the country.

Quite a noticeable feature of the Lake Eyre rivers is that towards the South Australian border the three major streams swing westwards abruptly. The Cooper turns almost at right angles in latitude 27° 40′

after an earlier but less striking bend near Windorah. The Diamantina takes a similar turn about latitude 25° 30′ and the Georgina near latitude 25° S. Mr. Wynne Williams lately has drawn attention to this in an unpublished observation and has suggested that the explanation may be found in a recent sag in the Lake Eyre region causing the streams to be deflected from their courses. It was suggested that the Wilson is really the original lower portion of the Cooper and that Lake Machattie and the Bilpamorea Claypan are on the line of the original lower reaches of the Georgina (see fig. 6). This matter is mentioned with Mr. Wynne Williams' permission since, from quite other premises (see above, p. 6), a recent sag in this region has been suggested. There may, however, be some other contributing cause, for instance resistant residuals which do occur near these bends deflecting the streams; for the Georgina, in latitude 23° S. and under similar conditions, makes an equally abrupt turn to the east.

THE LAKES.

Lakes of this region are very shallow pans that, for water storage, are not so permanent as the waterholes of the rivers. Many are parts of the larger river systems, others are small centres of inland drainage. There is no vital distinction between them and claypans, the latter holding a little water after rains, the lakes being more lasting. Any real difference is in the more reliable water supply to the lakes. For convenience they may be treated as two groups—the lakes along the Great Divide on the Alice Tableland and those further west.

The Lakes of the Alice Tableland (fig. 5).—Along the eastern edge of the Great Artesian Basin the several earlier series of the Mesozoic sediments outcrop as marginal fringes. Most easterly is the belt of the oldest sediments, the Bundamba Series* (mainly sandstones). Then westerly, as succeeding deposits, follow the Marburg Series (fine sandstones and shales), the Walloon Series (clays and calcareous sandstones), the Blythesdale Series (very variable sediments mainly arenaceous), and finally the Cretaceous shales that cap the Basin. All of these in Central Queensland are covered by the continuous sheet of laterite that forms the Alice Tableland. Away from the tableland and its laterite sheet the Walloon Series, as viewed from high vantage points, forms a slightly depressed zone between the more elevated sandstone series on either side.

These belts, by a variety of evidence, may be traced through the region of the Alice Tableland, the Walloon Series occurring as a ribbon-like strip that here too forms a depression—depressed so slightly that it may be appreciated only by running a series of east-west levels or aneroid traverses. In this slight depression lie the two large lakes of inland and suspended drainage—Lakes Galilee and Buchanan. Buchanan is broadly fusiform; Galilee is roughly L-shaped with irregular western and southern shores due to promontories of laterite.

* In work now in progress on the Mesozoic sediments of Western Queensland local serial names were employed until such time as proper correlation with the standard succession in South-Eastern Queensland could be made. In an earlier paper (Whitehouse, 1940) some of these local names were quoted. Since then considerable advance has been made in correlative work so that now the standard names are employed. The equivalent names of that earlier paper are as follows:—Dooloogarah Series=Bundamba Series; Attica Series=Marburg Series; Cunno Series=Walloon Series.

Each lake is approximately 17 miles long. Neither has any outlet at present. There is no indication that Buchanan ever had one. An old channel connects the south-west of Galilee with Reedy Creek (of the western waters), but never apparently in human memory have waters from the lake flowed through to Reedy Creek. When rain does fall the main portion of the channel is a waterway to Reedy Creek; but about 5 miles from the lake the water flows lakewards. When recently filled in a good rainy season Galilee may be fresh at the southern end and brackish at the northern (as Danes has noted). Buchanan is always brackish when newly filled and both dry back to salt lakes and salt pans. Coarse salt is gathered and used locally from natural pans at the northern end of Buchanan. Apart from concentrations in the normal processes of inland drainage the salt content of the lakes is increased by the saline nature of the local laterites (see Whitehouse, 1940, p. 67).

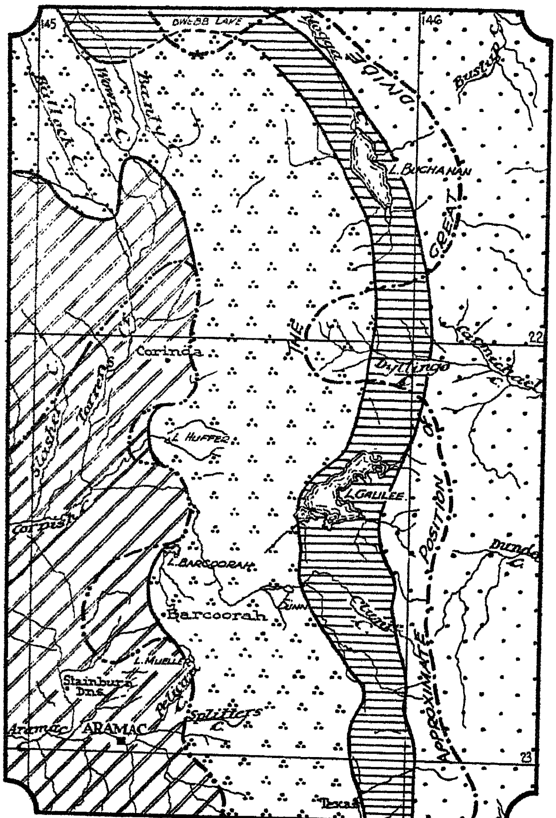


FIG 5. THE LAKES OF THE ALICE TABLELAND.

MARINE CRETACEOUS (TAMBO SERIES) — BLYTHESDALE SERIES

WALLOON SERIES — EARLY MESOZOIC BEDS. (BUNDAMBA & MARBURG SERIES.)

—··—··— WESTERN EDGE OF LATERITIC SOILS.

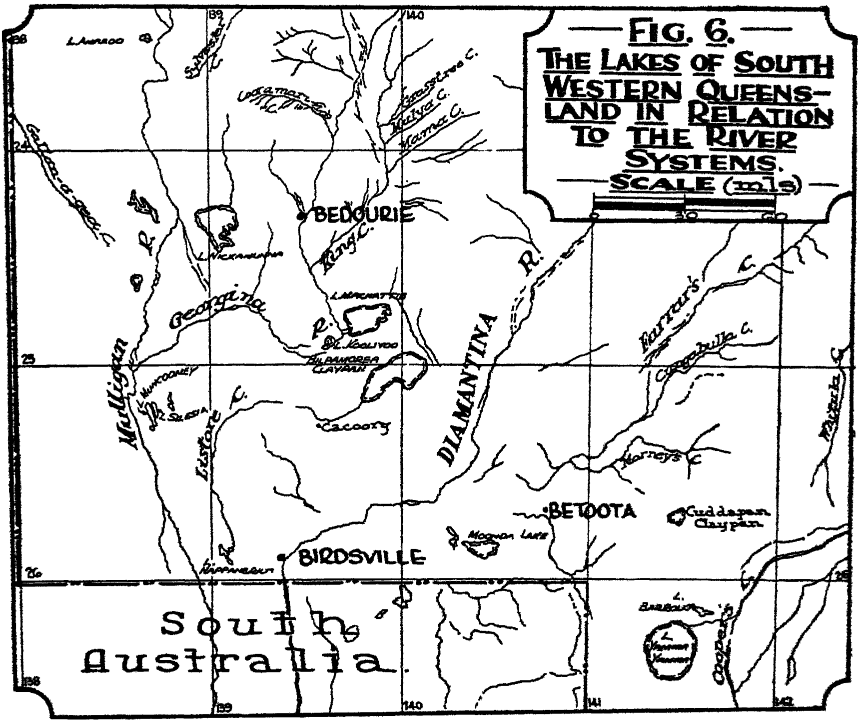
SCALE 0 16 32 MILES.

TEXT FIGURE 5.

Two main streams feed Lake Buchanan—Mogga Creek from the north and Bowie Creek from the south. Each enters through ramifying channels of a typical delta. Danes (1910, p. 92) has described a linear (N.N.W. to S.S.E.) arrangement of the claypans around the southern end of the lake. As seen from the air this is revealed as silt pans subdivided by ridges of sandy silt parallel to the delta channels.

Shallow excavations near each lake (a dam on Tanka Creek near Galilee and the deep banks of Dinner Creek that enters Buchanan) show that the clays of the Walloon Series occur close to the surface covered merely by the silts.

A few small lakes occur also in the region. Some (Webb's Lake) are tiny basins of inland drainage. Others (Lake Barcoorah) are on western waters.



TEXT FIGURE 6.

The Far Western Lakes (fig. 6): With a few exceptions such as Lake Dartmouth (Lake Ambathala), all of which are in the Central Region, the more western lakes are confined to what I have called the South-Western Region. There are a few sheets of water often called lakes, for example, Lakes Idamea and Wonditti on Pituri Creek, which occur on river channels. These are elongated structures, really waterholes slightly wider than usual. The more equidimensional basins are never on the river courses. The largest, Lakes Yamma Yamma, Machattie and Wickamunna, are parts of river systems but lateral to the streams. Yamma, the largest lake, is a subcircular pan 18 to 20 miles in diameter. It is connected to the Cooper by a single, long

channel, Gilpeppie Channel. When the river floods the water flows to the lake through this conduit, and as the flood subsides it flows out again by the same vent until the lake assumes its normal, full size. Then it is fresh but very shallow. As a long, dry season advances the shores recede and clover, good cattle feed, grows along them. Progressively the waters become brackish, then salt, and the lake eventually may dry up. Machattie is of the same type with several channels from the Georgina, though being smaller its waters are less lasting. Wickamunna had a similar relationship to the Mulligan, but a sandhill has grown across its channel and nowadays it is a salt pan. Further along the Mulligan is the double pan of Muncooney and Silesia. Originally this was one lake, laterally filled from the Mulligan; but a sandhill has grown through it, dividing it into two parts, and only that nearer the river (Lake Muncooney) is now filled. Silesia remains dry. The great Bilpamorea Claypan, 28 miles long and up to 10 miles wide, really is a lake lateral to the Diamantina, but nowadays its channels are greatly blocked by sand.*

Other western lakes, smaller in size than these, are not lateral to the rivers but fed by distributaries that end in them. Such is Lake Numalla, fed from the Paroo. Others, for instance Lake Dartmouth, Bulloo Lake and the Jerrira Swamp, are true basins of inland drainage. Many of these are salt; but the main salt lakes are the small pans around and west of the Mulligan.

Two General Aspects: There is a pertinent comparison of the western lakes with the larger lagoons of Eastern Queensland. They, too, for the most part are lateral to the streams or are separate small basins on the plains. Rarely, as with Lake Nuga Nuga on the Brown River, are they directly upon the watercourses. The most magnificent development possibly is in the Taroom District where all the larger tributaries of the Dawson (Scott, Eurombah, Palm Tree, Robinson, Gwambegwine, Turtle, Tualka and other creeks) are fringed with many large, shallow lagoons, fed by channels from the parent stream in periods of flooding, with some accessory local drainage to them. Such basins almost invariably are in regions of soft, calcareous rocks—shales

* The following notes about Bilpamorea Claypan, kindly supplied by Mr. C. C. Morton of Roseberth, Birdsville, graphically illustrate the mode of supply of these great depressions; and they show how, in dry periods with accelerated growth of sand dunes, dry lakes like Wickamunna have been formed.

"Bilpamorea Claypan fills from the Diamantina. There is a channel (Murraturley), really an outside channel of the Diamantina, that helps to fill it. But being blocked by sandhills it does not run right to the big claypan. In flood times the channel overflows and spills into Bilpamorea. Between the sandhills there are several claypan flats that are the ends of smaller channels from the river, and overflows from these also go to the pan. No channel exists between Bilpamorea and the Georgina River. When the claypan is filled by the Diamantina flood waters and the Georgina also is in flood the two waters are less than twelve miles apart. Bilpamorea can be filled also by local rains, but only in very good seasons, since several large creeks run into it. About 1920 was the last time that it was filled from local falls, although often since then it has been half filled. The droughts and dry times during the past twenty years have caused sandhills to grow across the claypan flats, so that it might easily happen that the Diamantina flood waters may never get to Bilpamorea again. The same thing has happened on the Cooper, seven or eight miles above Kopperamanna in South Australia. A sandhill, and a big one, has grown right across the river. The last floods through to Kopperamanna were in 1918, twenty-three years ago, so that the next floods will have some clearing to do. At the next flood it will be interesting to see where the water will go before it eventually breaks through—if ever it does break through."

and calcareous sandstones. The territory of the little-disturbed Walloon Series, as a whole a depressed region, particularly is characterised by such lagoons. Others occur on flat-lying Permian sediments of similar lithology.

Above it has been noted that the two near-western lakes, Galilee and Buchanan, are on the Walloon belt. The other western lakes are in the province of the calcareous Cretaceous beds that form the cover of the Great Artesian Basin, and these are concentrated in the South-Western Region where, as mentioned previously, the dissection of the laterites is virtually complete, base level being approximately at the top of the Cretaceous shales. It may be advocated, accordingly, that the shallow lakes of Queensland are developed in slight depressions, formed by erosion and some solution in regions of flat-lying soft shales and calcareous beds. One curious feature, however is that they do not occur in the "Inter-Lateritic Region" where one would expect ideal conditions.

The border between Queensland and South Australia is defined by lines of latitude and longitude. It is an artificial division. Yet, when reviewing lake and river types, there is something almost natural about the border line. Across into South Australia the active flood plains of the rivers increase quickly in width far in advance of what is known in Queensland and, correlatively, there is an amazing spread of lakes, far more exuberant than the lake system of the far south-west of Queensland.

THE SANDHILLS.

In many regions of the laterite residuals reddish sands largely accumulate. Outwashed from the laterites of the Alice Tableland great red sand drifts occur far down the Barcoo. In the South-Western Region there is also a widespread development of red sandy silts with lateritic ingredients. From such sources, most likely, come the materials of the wind-formed sandhills of the far south-west, the region of the Simpson Desert. In its most arid portion, near the western border of the State, the sandhills are arranged in long, serried rows and on an average are a quarter of a mile apart. Between are claypans, alluvial flats and small sand drifts. Some of the great dunes may be as much as 80 miles in length. Although in literature dunes 100 feet high are mentioned, a sandhill of 50 feet would be a fairly tall one. They are aligned in a N.N.W. direction and usually are steepest to the east. They may remain parallel and apart for great distances, but sometimes adjacent dunes join by a cuspate connection. Yet they are monotonously similar, and small, crescentic, cross-wind dunes of the barkhan type are not developed. Easterly this region of the serried dunes is continued a little beyond the Mulligan River, but there are some outliers from this zone. Most important of these is the area immediately east of Lake Machattie.

Still further east is a region of isolated and sporadically placed sandhills with the same alignment and slope directions as the grouped dunes. This area ends at the Cooper. Beyond that line are only non-active, eroding, vegetated dunes and some irregular sand drifts related to the old red silts. The easterly, active sandhills between the Mulligan and the Cooper are of quite recent origin, for they ride upon the alluvia in the present flood plains of the streams.

Bagnold (1937, p. 435), from intensive studies in the Libyan Desert and careful laboratory experiments in a wind tunnel, has shown that for the production of a dune system like that west of the Mulligan it is necessary to have a multiple wind system. The dunes align according to one prevalent wind group and multiply in the direction of another active cross wind. (According to Bagnold the latter system is that of the prevailing wind). Madigan (1936) who has published excellent aerial photographs of the Queensland sandhills has shown that the large grouped dunes of the Australian deserts are developed parallel to the prevailing wind. Very probably, therefore, the isolated sandhills between the Cooper and the Mulligan are lately formed dunes encroaching eastwards in response to an effective minor wind system.

There is very little movement to-day of the sandhills in Queensland. Residents to whom I have spoken, who have been twenty, thirty or more years in the sandhill region, unanimously agree that the big sandhills are fixed and are not growing. Ratcliffe (1937, p. 6) from his observations is convinced that movement of established dunes is negligible in this State. Yet in a very dry season, when the binding action of the contained moisture is lowered, a slight increase at the northern end of a dune often is noticeable; and with a series of very dry seasons, as already noted in the Bilpamorea region, minor sandhills may form in the more arid parts where there are wide expanses of claypans or flooded country. This seems to be the only appreciable movement and it is irregular. I have seen no indication of the growth of new dunes in the eastern region. Beyond the Cooper the surface sands are not piled into large dunes.

There are certain limiting conditions under which desert sandhills may grow—based on moisture content and wind pressure. It would seem, from these indications, that in the region as far east as the Cooper such conditions are just sufficiently established to maintain the dunes without causing any considerable extension. A variation of conditions—possibly with greater winds but definitely with a more arid season—causes the only noticeable growth. That is, conditions for sandhill growth are now in equilibrium in this region. But, as I have shown elsewhere (1940, p. 67), such conditions previously existed considerably further east—at least 120 miles further. "Dead" sandhills, now vegetated and being eroded, occur so far. This indicates extended conditions—either greater wind power or slightly more arid conditions, probably the latter—in the not far distant past.

When the time comes to test these things quantitatively and to determine what lateral movement, if any, of the big dunes has been made, one record will be of outstanding value. When, in 1881, Poeppel made the difficult survey of the border between Queensland and South Australia he carefully fixed the position of every sandhill that he crossed in his long, arduous traverse through the desert. Two copies of his plan exist in Government offices—the original in Adelaide and a duplicate in Brisbane. This will form an ideal basis for a comparative survey.

In the very arid region of the south-west of Queensland occur the "gibber plains" of Sturt's Stony Desert, corresponding in their mode to the hammeda types of desert elsewhere. These are lateritic remnants, being dissected sheets of the siliceous zone of such old soils and are not confined to the desert region. They are quite as impressive just west of the Paroo River as they are in the arid corner.

THE MOUNTAINS.

It is not proposed to discuss in detail the mountain groups of Western Queensland, since essentially this is a study of the plains. But one aspect of the mountains is related closely to flat land features.

Apart from sand dunes, basalt hills and the laterite residuals there are two types of elevated land forms in Western Queensland. Near the western border immediately south of the tropic of Capricorn is a step-faulted scarp of horizontal Ordovician sandstones (the Toko Ranges) some 60 miles long, aligned in a south-easterly direction. Although called "ranges" they are rarely more than 100 feet above the fronting plains.

The most important ranges however are the rugged lands in the folded Palaeozoic and Pre-Cambrian areas. In the north-west (the pertinent region for these purposes) such highlands are strike ridges mainly of old quartzites. Generally they are north-south ranges; but occasionally when the rocks are closely folded they have more complex lines.

Rarely do these features appear upon the maps; for a study of drainage lines gives little clue to the existence of such barriers. Such western rivers as the Gregory that rise beyond the ranges and flow through them on to the coastal plains are not modified in their courses as they pass through. Actually the Gregory through these meridional ranges has an easterly course. Streams like the Leichhardt that rise within the ranges and flow out on to the northern plains are for the most part in strike-valleys between the ranges (with short easterly reaches), and they retain the same directions upon the plains lower in their courses. And yet, for ordinary travelling, these ranges are real and rugged barriers. Mount Isa is some 65 miles due west of Cloncurry; but the railway has to go a long distance south-west to get into a suitable strike valley and then turn northerly to get to Mt. Isa. It seems likely (published studies near Lawn Hill that already have been quoted are most informative) that the present streams in those regions took their origin on the higher, pre-existing plains of Pliocene and Pleistocene deposits, and that such deposits (laterite and old alluvia) are now almost entirely denuded, leaving the rivers of the earlier plainlands superimposed upon the present rugged country.

SOME ECONOMIC CONSEQUENCES.

Except for some agricultural development in the south-east the plains of Western Queensland are used only for the raising of stock. The brown pedocalcic soils of the Downs and of the more recent alluvia grow rich Mitchell and other grasses. The old red silts of the south-west have a shrub and tree vegetation in which mulga is conspicuous. The hills of laterite residuals support a varied growth, but not of Mitchell grass, the variety being in response to the varied origin of the laterite soils and to the differing composition of the several soil horizons and their derivatives. In this way there is a considerable variety of plant communities and of fodder regions for pastoral and grazing purposes.

The region is one of low rainfall and of summer rains. Surface water is scanty, for only one river, the Gregory in the far north-west, has a permanent flow. Elsewise the lakes and waterholes have the only

natural, permanent surface waters. The most desirable properties are those with river frontages on wide flood plains. There, after a flood, even if little or no rain falls locally, the spreading waters fill the waterholes and grow the grass and herbage. For the far western rivers, where the active flood plains and channelled zones are of great width and where local rainfall is very scanty, this is particularly important. There, in a minor flow, a few channels run; with greater waters more channels are filled but water only is provided, no growth of fodder. Only with good flood conditions is there sufficient flow to charge all the channels and to spread the waters laterally across the inter-channelled area, thus to start the growth of pastures in a good season.

Irrigation, consequently, to supplement water reserves for pastoral purposes as distinct from the intensive watering of agricultural plots, is difficult to contemplate in the far western portions. Large dams are a standard means of flood prevention; and flood prevention in those parts is precisely what it is necessary to avoid. Also there are local difficulties in the construction of large dams. Such is the general flatness that few places could be cited in Western Queensland where it is possible to build a wall between the laterite hills that would impound a large quantity of water. So many old channels and natural waterways occur around the residuals that storage capacity is very limited. Along the Gregory, with its permanent flow, or in the region of the older, folded rocks, are possibly the only adequate sites.

In the more easterly regions and particularly in the south-east, where rainfall is greater and there are more lasting supplies in the rivers, the spreading flood waters are not so important. Here, then, are better opportunities for water conservation. Weiring of such rivers as the Condamine and the Macintyre is being undertaken and will no doubt be considerably extended in the future. In such a fashion some of this province is changing from a pastoral to an agricultural region.

And so the merits of large-scale conservation schemes of other countries hardly are applicable. Here there are no permanently and reliably flowing rivers such as the Nile, the Indus and the Colorado, and there are the added difficulties of inadequate sites. It has been suggested that ample waters from the coastal highlands in the far north-east might be deflected inland to flow the Thompson and the Cooper as a permanent stream; but it is yet to be demonstrated by surveys whether this actually is possible. Generally it would seem that the future of surface water conservation in Western Queensland must be in many small schemes rather than a few large constructions. That, in essence, would be an amplification of present methods; for it is standard practice on these pastoral properties to conserve surface water by excavating earth tanks on very small streams of little gradient, where the tendency to silt is at a minimum.

The western lands as a whole, at present, are far from sufficiently provided with usable water. But one may, perhaps, envisage a time when, progressively improved by small dams (and in the more favoured parts by weirs) the country may even rely essentially upon such surface storage, with the great resources of the Artesian Basin as merely an accessory supply.

The problem of providing storage water is becoming more insistent, by the development of closer settlement and by the serious diminution of present supplies. Over most of Western Queensland it is evident that springs are declining; that waterholes are silting; and that supplies consequently are less lasting. Three factors mainly are responsible.

1. A general decline since Pleistocene times. The springs of the Great Artesian Basin naturally are decreasing as the basin is more and more tapped by bores. But away from its margins the great springs seriously are becoming less. The enormous springs that feed the Gregory River have been declining ever since the region has been settled. A similar decline is noticeable in another area of very great springs—in the Bundamba Sandstone belt at the head of the Maranoa, Warrego and Nogoa Rivers. Carnarvon Station in that region, for example, when first taken up was watered entirely by surface supplies. To-day there is not a permanent waterhole on the property, many of the springs have ceased and the remainder have noticeably lessened. I have attempted to show (1940, pp. 51-53) that, in the region of the Gregory, the decline may have begun shortly after the Pleistocene, since when rainfalls have been less. The same is likely true of other areas.

2. A general decline over the past two decades. The last twenty years seems to have been, as a whole, a lean period for rainfall, particularly in the far western regions. It is over twenty years since there have been floods large enough for the waters of the Cooper and the Diamantina to reach Lake Eyre. In those regions, consequently, the floods have less volume and less power; and they tend more to silt than to scour.

3. Soil erosion. Through a decline of vegetation run-off is more rapid and the volume of transported silt is larger than formerly. This decline, noticeable in many countries of the world, is here only partly due to such human agencies as clearing of timber and overstocking of pastures. There has been a natural decrease of vegetation, due to bad seasons, that has contributed largely to the silting processes.

Thus two of these factors are beyond human control and the third only partly is subject to arrest. The natural diminution of surface waters consequently must increase. Even if the next decade or the next few decades are of good seasons the silts that have been accumulating in the former good waterholes may now be so consolidated that natural scouring may remove relatively little of the material. That being so the problem of providing other surface supplies is quite urgent in the economy of Western Queensland.

And so to-night I have attempted to place before you a picture of the western portion of our own State, a land curiously unlike the flat lands that have been described from countries overseas. It has its own peculiarities of surface structures; and associated with them are problems of maintenance that may have to be solved by methods as novel as are the features themselves. I think that I am right in believing that in these lands we have developed semi-arid country more profitably than has been done in any other continent without irrigation. And it is comforting to think, that by progressive improvements that readily can be visualised, such development can be extended considerably by future generations.

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ADDITIONS TO THE MOSSES OF NORTH QUEENSLAND.

By H. N. DIXON, M.A., F.L.S.

(*Communicated to the Royal Society of Queensland by C. T. White, 28th April,* 1941.)

For some time past I have been receiving specimens of mosses for determination from the North Queensland Naturalists' Club, sent by various collectors and mostly from the neighbourhood of Cairns. They continue to show an interesting bryological flora, some localities, for example the rain forest area and Mt. Bartle Frere, suggesting promising new fields of study.

Watts and Whitelegge (1902, 1905) in their Census Muscorum Australiensium give a number of Queensland localities; while highly interesting contributions to the Queensland moss flora were made by F. M. Bailey; but the greatest additions were made by Brotherus and Watts (1918).

The present paper includes about a score of new species, together with a number of species—including two or three genera—newly recorded from Queensland. The newly recorded species are marked by an asterisk.

Watts, in the paper mentioned above, speaks of the North Queensland flora as more closely related to the Malaysian than to the Australasian. The affinities of the new species and the newly recorded ones, in the present paper, are about equally divided between the two floras.

I have included a number of records of mosses collected in 1922 by T. Vaughan Sherrin, mostly in the neighbourhood of Ravenshoe, and sent to me by Mr. W. R. Sherrin.

F. M. Bailey (1890) adds eight species of mosses to his list. These were collected by C. J. Wild and determined by Brotherus, all but one being new species. Of these, five I believe are unpublished, but I have not had access to the material, and have been unable to describe them.

The types of the new species are in my herbarium.

FISSIDENTACEAE.

FISSIDENS PATULIFOLIUS Dix. sp. nov.

Bryoidium. Dense, late caespitosus, sordide viridis, sat robustus. Caulis circa 1 cm. longus, crassus; frons *lata*, circa 2 mm., complanata. sicca dorso, *propter folia fortiter decurvo-falcata, convexa*. Folia patentia, parum conferta, 1 mm. longa, ·5–·6 mm. lata, breviter, *latissime oblongo-ovata*, haud acuminata, *acute apiculata*, ubique pellucide limbata, integra; costa *concolor*, in apiculo soluta. Lamina vaginans circa 2/3 folii attingens, *apice truncato;* lamina dorsalis apud basin angustata, haud decurrens. Cellulae parvae, distinctae, chlorophyllosae, *regulariter, aequaliter hexagonae*, seriatae, laeves, basilares vix mutatae.

Fructus ignotus.

R.S.—D.

Hab. Forming a large, dense mat on stem or root of tree, more or less submerged, in rain forest, Tully R., above Tully Falls, 1 Oct. 1939; coll. H. Flecker (6302).

Much encrusted with calcareous deposit, but when clear often of a bright green, with a succulent appearance, and in that condition showing the leaves strongly falcate and decurved when dry. It is very distinct in the large, widely oval-oblong, rather distant leaves. The broadly truncate apex of the vaginant lamina is peculiar.

FISSIDENS CAMBEWARRAE Dix. sp. nov.

Semilimbidium. Sat robustus, sordide viridis, caespitosus. Caules 1–1·5 cm. alti; folia sat conferta, sicca crispata, 1·5–1·75 mm. longa, lingulato-lanceolata, breviter acuminata, *cuspidata seu robuste apiculata*. Lamina vaginans circa 2/3 folii aequans; lamina dorsalis ad basin *abrupte* desinens; lamina vaginans sat fortiter hyalino-limbata, margines reliquo minute crenulati. Costa pallida, percurrens. Cellulae *minimae*, opacae, parietibus tenuibus, pellucidis, sat alte acute papillosae.

Heteroicus; flores ♂ nonnunquam in caule fertili foliorum inferiorum in axillis siti, nunc in ramo proprio. Seta tenuis, *brevis*, basi geniculata, circa 3 mm. longa. Theca erecta, minuta.

Hab. Among Hepaticae, in jungle, on soil, Cogzell's Farm, near Tully River, Lower Tully, Sept. 1937; coll. Miss E. Henry, type. Cambewarra Mountain, N.S.W., coll. W. W. Watts, 22 May, 1903 (6373).

The N.S.W. plant is identical with the Queensland specimen, though a slightly different form. I had given the name to the former, received some time ago from the collector, but as the Queensland plant is in fruit I have made it the type.

F. cairnensis Broth. & Watts, the only other species of Semilimbidium known from Queensland, is quite different in cells and fruit. The present is an unusually robust plant for this Section. The base of the dorsal lamina usually ends abruptly, but varies somewhat.

FISSIDENS MICRO-HUMILIS Dix. sp. nov.

Crenularia. Humillimus, dense gregarius, pulchre fructificans, viridis. Caules brevissimi; folia conferta, sicca haud crispata, subfalcata, parva, *lingulata, acute acuminata, plerumque apiculo acuto pellucido* terminata. Lamina vaginans medium folium superans, *media lamina* terminata; lamina dorsalis *longe angustissime decurrens*. Margines integri, omnes elimbati. Costa perpellucida, in apiculum excurrens. Cellulae parvae, parietibus tenuibus, pellucidis, *laeves*, inferiores paullo majores.

Autoicus. Flos ♂ ad basin caulis fertilis situs. Seta tenuis, flexuosa, 2–3 mm. longa, basi geniculata; theca minuta, erecta, anguste elliptica, in setam defluens, sicca sub ore contracta, urceolata.

Hab. Upper Mowbray R., 11 Nov. 1938; coll. Mrs. Sparvell (5873).

Very like my *F. humilis* from N.S.W., but on a much smaller scale, and with much narrower, less lanceolate leaves, and weaker nerve.

Fissidens arboreus Broth.—Hab. Jungle, Cogzell's Farm, Lower Tully, coll. Miss E. Henry, Sept. 1937 (4458).

Fissidens asplenioides Hedw.—Duma Creek, Ravenshoe, Summer, 1922 coll. T. V. Sherrin (1).

MOENKEMEYERA AUSTRALIENSIS Dix. sp. nov.

Inter Hepaticas, etc., gregari; sordide, pallide viridis, sat mollis. Caules plus minusve elongati, infra fructum saepe innovantes. Folia dense conferta, 1 mm. longa vel paullo ultra, *lingulato-spathulata,* apice *rotundato-obtusa,* integra vel minutissime papilloso-crenulata; omnia elimbata nisi folia interna perichaetialia, ubi nonnunquam limbus rudimentarius fere obsoletus invenitur. Costa angusta, pallida, translucens, saepius infra summum folium soluta. Lamina vaginans paullo medium folium superans, apice plerumque media lamina obtuse terminata. Lamina dorsalis infra angustissime decurrens, folii basin attingens. Cellulae minutae, obscurae, irregulariter hexagonae, humillime inconspicue papillosae. Seta *brevissima,* vix 1·5 mm. longa, viridis. Theca minuta, elliptica, erecta; peristomium e dentibus 16 *pulchre rubris,* filiformibus, infra latioribus, *simplicibus, nullo modo fissis,* vix trabeculatis, *ubique alte, dense papillosis,* ad basin saepe cohaerentibus, instructum. *Spori parvi.* Operculum haud visum.

Hab. Rain forest, Lower Tully, near Tully River, Sept. 1937; coll. Miss E. Henry (4458).

The undivided peristome teeth preclude *Fissidens.* On the other hand, their well developed, highly papillose structure is unlike that usually found in *Moenkemeyera,* which, however, shows a considerable variety in this organ. The very short seta, however, is a definite generic character, and the leaves are almost identical with those of the Cameroons *M. macroglossa* Broth.

The genus has hitherto been known only from tropical America and Africa, and from a single, unpublished species from Rarotonga. This seems a suitable opportunity to describe that species, a short description of which is given below.

MOENKEMEYERA RAROTONGAE Dix. sp. nov.

Corticola; pulchre viridis. Cellulae axis corticales magnae, elongatae, lineares, curvatae. Frons circa 5 mm. longa, flabellata. Folia patentia, sicca leniter decurvo-falcata, inferiora squamata, late ovato-acuminata, superiora lineari-lanceolata, peracuta, immarginata, pulchre aequaliter crenulata; costa perpellucida, nitida, in apice soluta. Lamina dorsalis ad basin lata, abrupte terminata. Lamina vaginans circa medium folium attingens, apice acuto. Cellulae parvae, perdistinctae, hexagonae, opacae, parietibus perpellucidis, sat alte sed obtuse unipapillosae. Folia perichaetialia interna e basi late ovata abrupte lineari-subulata, inferne obsolete hyalino-marginata.

Seta perbrevis, circa 2 mm. longa, pallida, basi geniculata. Theca erecta, minuta, collo distincto. Peristomii dentes parvi, irregulares, imperfecti, nunc integri nunc breviter irregulariter fissi, sub ore oriundi, infra trabeculati, supra leniter papillosi. Spori circa 14 μ. Operculum rostellatum.

Hab. On bark, Rarotonga, Cook Is., Jan., 1935; coll. A. F. Graham, comm. Miss L. B. Moore (23).

A pretty little species, resembling, like most of the genus, species of *Fissidens* of the Section Crenularia. It differs from the Queensland species at once in the acute leaves, non-decurrent base of the dorsal lamina, and distinct cells. The peristome teeth are mostly entire, but sometimes shortly and unequally divided.

DICRANACEAE.

DICRANELLA DIETRICHIAE (C.M.) Jaeg.—Millaa Millaa, 5 May, 1939; coll. Mrs. Sparvell (5946).

DICRANELLA PYCNOGLOSSA (Broth.) Par.—Road cutting, Beatrice R., Cairns, 28 June, 1938; coll. H. Flecker (5004). Upper Mowbray R., 24 Nov., 1938; coll. Mrs. Sparvell (5876).

DICRANELLA EURYPHYLLA Dix. sp. nov.

Humillima; gregaria, *laetevirens*. Caules pauca mm. alti, ad basin radiculus et protonemate obruti, molles, densifolii. Folia 2–3 mm. longa, *patula, curvata*, e basi concava, latiore *sensim in laminam ligulato-lanceolatam, latam, obtusam vel subobtusam, integram* (nonnunquam ad apicem obtuse dentatam) angustata. Costa sat angusta, viridis, inde obscura, latiuscula, tenuis, cum vel sub apice desinens. Cellulae *latae, magnae*, ad basin elongate lineari-rhomboideae, parietibus tenuibus, saepe breviores, chlorophyllosae, versus apicem *breviter late rhomboideae, inanes.*

Dioica. Seta tenuis, *pallida*, 5–6 mm. alta; theca *elliptica, parva, erecta, aequalis, laevis*, pallide fusca vel fusco-viridis. Operculum longirostrum. Peristomium rubrum, dentes parvi, sub ore siti, ad basin conniventes, remote trabeculati, *ubique striolati, haud papillosi.* Spori circa 20 μ.

Hab. Terrestrial, Upper Mowbray R., 24 Nov., 1938; coll. Mrs. Sparvell (5877).

A pretty little species, distinct in its small size, wide, obtuse leaves, and lax, pellucid, chlorophyllose cells.

HOLOMITRIUM MUELLERI Hampe.—Barron Gorge, 3 July, 1936; coll. S. Egan (1935).

HOLOMITRIUM PERICHAETIALE (Hook.) Brid.—Duma Creek, coll. T. V. Sherrin (4, 5, 7).

DICRANOLOMA DICARPUM (Hornsch.) Par.—Duma Creek, coll. T. V. Sherrin (13). A slender form.

DICRANOLOMA MENZIESII (Tayl.) Par.—Eastern slope, rain forest, Mt. Bartle Frere, North Queensland, coll. H. Flecker, 28 Oct., 1939 (6377).

DICRANOLOMA ELIMBATUM Dix. sp. nov.

E minoribus generis. Caules minusquam 2 cm. alti, straminei, curvati. Folia subfalcata, sicca minime mutata, divergentia, 4–5 mm. longa, e basi *sat angusta* oblongo-lanceolata, *sensim breviuscule latiuscule* acuminata; margines *omnino elimbati*, e medio folio sensim magis magisque fortiter dentati, apud apicem una cum costa dorso argute fortiter spinulosi. Costa mediocriter valida, circa 40 μ lata, ubique subaequalis, versus basin tenuior et minus definita, *superne crassior et optime delimitata, longiuscule excurrens*, fusca. Cellulae basilares sat late lineares, parietibus firmis, paullo porosis, marginales similes, superiores breviores, irregulariter rectangulares, parietibus *incrassatis, haud porosis; juxta-costales* breviores, *saepe brevissime rectangulares;* alares conspicuae, majusculae, *late isodiametricae.*

Fructus ignotus.

Hab. Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (10).

A small species, very distinct in the size, and in the structure of the leaves. The nerve is conspicuously stronger and well defined in the subula.

DICRANOLOMA AUSTRO-SCOPARIUM (C.M.) Par.—On bark in rain forest, summit of Talbunjie, alt. 2710 ft., 12 June, 1939; coll. H. Flecker (6085).

DICRANOLOMA SERRATUM (Broth.) Par.—(Syn. *Dicranoloma monocarpum* (C.M.) Par), Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (12, 14).

D. monocarpum, from N.S.W., is certainly, as suggested by Watts, the same thing, as is also an unpublished species, distributed as *Leucoloma Harrisii* Geh. ined., from Cambewarra, N.S.W.

LEUCOLOMA SUBINTEGRUM Broth.—On bark of tree, Platypus Creek, Cairns, 3 Jan., 1936; coll. H. Flecker, (1234).

DICNEMOLOMA CLAVINERVE (C.M.) Broth.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (3). A very peculiar and, no doubt, rare plant. Most of the leaves end in the remarkable clavate tip of the nerve, which is easily broken off and is no doubt a reproductive organ, but in a few cases the upper leaves show a short, glistening, hyaline hair point, which was not observed by C. Mueller.

*CAMPYLOPUS NOVAE-VALESIAE Broth.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (16, 17, 21). The fruit of this species has not been described. No. 21 shows a few young capsules; the calyptra is fringed at the base.

CAMPYLOPUS WATTSII *Broth.*—Cairns, 13 Nov., 1935 (979). Barron Gorge, 3 July, 1936; coll. S. Egan (1949). Moist banks of Campbell's Creek, 16 May, 1937; coll. H. Flecker (3274). Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5937).

This is an unsatisfactory species. Brotherus describes it as "C. (*Rigidi*) Wattsii," and it is placed by him, in the "Musci" in that subsection of Palinocraspis. Type specimens distributed by Watts, under the number 366, do not, however, show a Palinocraspis nerve at all, but that of Eu-campylopus. In his diagnosis, Brotherus does not give any description of the nerve Section. I can only suggest that the nerve is rather variable in its structure. In No. 979, and also in No. 3274, I have found the ventral cells in Section not much larger than the Guide cells, in fact, in the former, about equal in size. It is possible that Brotherus having sectioned a nerve of this character may have assumed it to be that of Palinocraspis. In any case, I think it must clearly be considered to be a species of Eu-campylopus.

CAMPYLOPUS WOOLLSII (C.M.) Par.—Campbell Creek, 17 May, 1936; coll. H. Flecker (1671). Beachview, Millaa Millaa, 5 Oct., 1937; coll. Miss E. Henry (3981).

CAMPYLOPUS INTROFLEXUS (Hedw.) Brid.—Alpine moor, Burrow's Creek, alt. 1200 ft., 21 Sept., 1936; coll. H. Flecker (2341). A pretty form of the male plant, with slender, shining, pale green stems, neatly comose at apex.

*CAMPYLOPUS CLAVATUS (R.Br.) Jaeg.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (23).

*CAMPYLOPUS BICOLOR (Hornsch.) var. ERICETICOLA (C.M.) Dix.—In sand on rock in stream, Herberton, 15 Jan., 1936; coll. H. Flecker (1330).

CAMPYLOPUS EXCURRENS Dix. sp. nov.

Eu-campylopus. Sat robustus, *olivaceus*. Caules 3–4 cm. alti, haud tomentosi, *propter folia conferta, aequaliter disposita, sicca adpressa,*

crassi, subteretes. Folia 4–5 mm. longa, e basi oblonga, parum concava, circa ·6 mm. lata, sensim in subulam concavam, *strictam, latam, integram* vel subintegram angustata. Costa versus basin ·3 mm. lata, supra sensim angustata, *in cuspidem robustum,* integrum, *acutum excurrens.* Costa sectione duces *magnos,* cellulas *ventrales parvas,* dorsales stereideas exhibens. Cellulae superiores breviter rhomboideae, infra sensim in basilares rectangulares transeuntes; basilares *laxae, breviter rectangulares;* infimae, ubi folii basis paullo dilatata, magnae, subquadratae, alas vix distinctas, male delimitatas instruentes.

Fructus ignotus.

Hab. Brown Bay, 11 Aug., 1935; coll. H. Flecker (703), type. Rocky bed of stream, North Toohey Creek, 23 May, 1937; coll. H. Flecker (3371).

The North Toohey Creek plant is a more robust form, with tomentose stems, the margin and excurrent point denticulate, and the margin towards apex curiously winged with blunt, hyaline teeth.

The habit, rigid leaves with excurrent nerve, and the basal structure are distinct. The leaves are slightly dilated at base so as to form auricles, but there is scarcely any marked delimitation of these cells, all the basal cells being pellucid, wide, and regularly subquadrate.

C. Wattsii Broth. has much longer, flexuose leaves, with large, hyaline auricles.

Campylopus umbellatus (W.-Arn.) Bartr.—Root's Creek track, in jungle, 5 Jan., 1936; coll. H. Flecker (1297).

LEUCOBRYACEAE.

Leucobryum sanctum (Brid.) Hampe.—Mt. Bartle Frere, 2 June, 1933; coll. H. Flecker (564). The unpublished *L. vesiculosum* C.M. is no doubt the same thing.

Leucobryum Bowringii var. sericeum (Broth.) Dix.—Barron Gorge, 3 July, 1936; coll. S. Egan (1948). A marked and pretty form (949).

Leucobryum candidum (Brid.) Hampe.—Mt. Spec, Cairns, Jan., 1940; coll. Miss E. Henry (6756). A rather remarkable form, growing on tree trunks in rain forest. It showed in many leaves a curious dilation of one side of the nerve, producing in cross section a very asymmetrical appearance, one side of the nerve being normal, while the other tapered into an extremely narrow, much longer wing, generally strongly inflexed. This condition was most developed about mid-leaf, and was sometimes so pronounced that it could be seen in the dry state with the lens, as a paler, almost membranous border or wing on one side of the leaf. It is, however, quite inconstant, and the plant must be considered a form only of *L. candidum.*

Forma brachyphylla. Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (11).

Leucobryum ballinense Broth.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (9). Murray R., 5 Oct., 1937; coll. Mrs. Sparvell (3914). Brown Bay, 11 Aug., 1935; coll. H. Flecker (702). Barron Gorge, 3 July, 1936: coll. S. Egan (1947).

The fruit of this species has not been described. Nos. 9 and 3914 are in fruit. The sporogonium is rather small; the seta 1–1·25 cm., slender; the capsule small, 1 mm. in length (deoperculate), or even less in the Murray R. specimen; struma small and not very distinct.

OCTOBLEPHARUM ALBIDUM Hedw.—(951).

ARTHROCORMUS SCHIMPERI Doz. & Molk.—Bark of tree, Campbell Creek, 17 May, 1936; coll. H. Flecker (1665).

*LEUCOPHANES CANDIDUM (Hornsch.) Lindb.—Jungle at intake, Mossman Gorge, 20 June, 1937; coll. H. Flecker (3499).

Not previously recorded from Australia.

LEUCOPHANES AUSTRALE Broth.—Jungle, Botanic reserve, Edge Hill, Cairns, 30 Nov., 1935; coll. H. Flecker (1060). Jungle at intake, Mossman Gorge, 20 June, 1937; coll. H. Flecker (3493).

The fruit of this has not, apparently, been described. No. 1060 bears apical jointed gemmae on the leaves.

EXODICTYON SUBSCABRUM (Broth.) Card.—Jungle, Mt. Bellenden Ker, 2 May, 1937; coll. H. Flecker (3134). I have no doubt that this belongs to Brotherus' species, though in some slight characters it differs from the description, being somewhat more robust than described, with branched stems, and with a rather different subula. It certainly is nearer to that than to any of the known species, and the differences do not seem to warrant the creation of a new species.

CALYMPERACEAE.

SYRRHOPODON CAIRNENSIS Broth. & Watts.—Upper Mowbray R., Cairns, 24 Apr., 1939; coll. Mrs. Sparvell (5863).

*SYRRHOPODON KINDELII Broth. & Par. (Syn. *S. parvicaulis* C.M.).—Bank of Burrow's Creek, Cairns, 21 Sept., 1936; coll. H. Flecker (2342). New to Australia. Distr. New Caledonia; New Guinea.

S. parvicaulis, the New Guinea plant, is exactly the same thing.

SYRRHOPODON CROCEUS Mitt.—(952).

SYRRHOPODON (THYRIDIUM) FASCICULATUS Hook & Grev.—Bark of tree, bank of Campbell Creek, 17 May, 1936; coll. H. Flecker (1656). This may probably be *S. subfasciculatus* Hampe, but it cannot be separated from the older species. It is a fine, robust form, with long stems, 10 or 12 cm. in length.

CALYMPERES TENERUM C.M.—On *Terminalia* bark, Low Is. Nov., 1928; coll. G. Tandy (3).

CALYMPERES MOLXUCCENSE Schwaegr.—Rocks in bed of stream, Tringilburra Creek, Cairns, 29 May, 1938; coll. H. Flecker (4734, 4742). This is an unusual habitat for a normally corticolous plant.

POTTIACEAE.

TORTELLA CALYCINA (Schwaegr.) Dix.—Lochaber Creek, Eidsvold, Apr., 1922; coll. T. V. Sherrin.

HYOPHILA MICHOLITZII Broth.—Prior Creek, Atherton, 17 Dec., 1938; coll. H. Flecker (5424).

I must confess that I find it difficult to see the difference between this and *H. involuta* (Hook.)

BARBULA INCERTA Dix. sp. nov.

?Helicopogon. *Fusca*, circa 1·5 cm. alta. Dense caespitosa. Folia patula, sicca *anguste convoluta, plus minusve spiraliter torta, circa* 2 mm.

longa, e basi convoluta latiore *sensim* in laminam lanceolato-lingulatam *haud acuminatam, late acutatam vel subobtusam, apiculatam* angustata. Margines inferne *leniter recurvi*, integri. Costa validiuscula, apud basin circa 50 μ lata, dorso superne *minute, distincte ruguloso-papillosa*, in apiculum saepius excurrens. Cellulae circa 8 μ latae, subquadratae, distinctae, seriatae, laeves.

Cetera ignota.

Hab. Prior Creek, Atherton, 17 Dec., 1938; coll. H. Flecker (5423).

Fairly distinct in the colour, the more or less spirally twisted leaves, their form, and the finely papillose or rugulose back of the nerve. I have given the name on account of some uncertainty as to whether the position is in Helicopogon or Eu-barbula.

PTYCHOMITRIACEAE.

PTYCHOMITRIUM MUELLERI (Mitt.) Jaeg. (Syn. *Brachysteleum commutatum* C.M.).—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (8).

ORTHOTRICHACEAE.

MACROMITRIUM SCOTTIAE C.M.—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5944, 5945, 5999).

MACROMITRIUM FUNIFORME Dix. sp. nov.

M. Weymouthii Broth. peraffine; *robustius; folia sicca* ad instar funiculi, *arcte, regulariter, spiraliter torta;* e basi *multo latiore, ovata, raptim acutissime acuminata.*

Fructus ignotus.

Hab. Rain forest, eastern slope of Mount Bartle Frere, 28 Oct., 1939; coll. H. Flecker (6411).

Very near to *M. Weymouthii*, but the leaves, besides being much wider at base, are narrowed into a very acute, often prolonged, acumen. In *M. Weymouthii* they are shortly and widely pointed. The funiform leaf arrangement is very marked, but I have seen similar forms in *M. Weymouthii.*

MACROMITRIUM PUGIONIFOLIUM C.M. Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (30).

M. HEMITRICHODES Schwaegr.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (31, 32).

MACROMITRIUM DIAPHANUM C.M.—Bark of tree, bank of North Toohey Creek, 23 May, 1937; coll. H. Flecker (3361). The name is given no doubt from the very unusual—in this genus—hyaline hair-point of the leaves. It is rather an unfortunate epithet, since the leaf is probably the most opaque in the genus! The upper part of the leaf is bi-tri-stratose all over, each cell with high bifid papillae. The colour of the lamina is glaucous green, the nerve is bright yellow, and the hair-point hyaline. The general effect of the colouring is that of *Tortula muralis*. It is altogether one of the most remarkable species of the genus.

MACROMITRIUM REPANDUM C.M.—On bare rock on ridge of Murray R. range, 600 m., 3 Sept., 1939; coll. H. Flecker (6275).

MACROMITRIUM DIMORPHUM C.M.—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5940).

MACROMITRIUM DAEMELII C.M.—Lochaber Creek, near Eidsvold, Apr., 1922; coll. T. V. Sherrin (6).

SPLACHNACEAE.

TAYLORIA HENRYAE Dix. sp. nov.

Fusca, brevis, gregaria. Caules circa 1-2 cm. alti, simplices. Folia laxiuscula, superne leniter subcomosa, 3-4 mm. longa, patenti-flexuosa, mollia, e basi *angustiore* lineari-lanceolata, vel *anguste spathulato-lanceolata, sensim breviter acuminata, peracuta, integra vel subintegra;* costa inferne validiuscula, fusca, in cuspidem *brevissimam, acutam sensim* excurrens. Areolatio laxa, cellulae superiores late rectangulares, parietibus tenuissimis, mollissimis; marginales angustiores; infra sensim laxiores.

Cetera ignota.

Hab. Hidden Vale, Mount Spec, Jan. 1940; coll. Miss E. Henry (6751).

The generic position of this moss is somewhat uncertain, but the foliation is so like that of *Tayloria octoblepharis* (Hook.) Mitt., that it is almost certainly allied. It differs in fact from that species only—but very markedly—in the leaf apex being shortly and acutely pointed, instead of being terminated by a long, flexuose, almost piliferous arista, as in *T. octoblepharis.*

The leaves are very hard to moisten out, and it is possible that they are normally somewhat wider than I have observed. In any case they must be much narrower than in most of the allied species.

BRYACEAE.

*BRACHYMENIUM INDICUM (Doz. & Molk.) Bry. jav.—Post Office Hotel, Mossman, 20 June, 1937; coll. H. Flecker (2507). Trinity Beach, 15 miles north of Cairns, 13 Feb., 1935; coll. H. Flecker (4106).

BRACHYMENIUM WATTSII Broth.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (33). Zoological Gardens, Edge Hill, Cairns, 20 Aug., 1908; coll. H. Flecker (5079).

BRYUM PACHYTHECA C.M.—Upper Mowbray R., 25 June, 1939; coll. Mrs. Sparvell (6160).

BRYUM BAILEYI Broth.—Upper Mowbray R., June, 1938; coll. Mrs. Sparvell (4943).

BRYUM ARGENTEUM Hedw.—Rocks in bed of North Toohey Creek, 23 May, 1937; coll. H. Flecker (3380).

BRYUM ROBUSTUM Hampe. ?.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (34).

I am not sure of this determination.

BRYUM SUBTOMENTOSUM Hampe.—North Toohey Creek, 23 May, 1937; coll. H. Flecker (3378). Millaa Millaa, 31 May, 1939; coll. Mrs. Sparvell (6194). Tully R., above Tully Falls, 1 Oct., 1939; coll. H. Flecker (7297).

BRYUM SUBFASCICULATUM Hampe.—Pine Creek, Cairns, 2 Aug., 1936; coll. H. Flecker (2093). A fine, robust form.

RHIZOGONIACEAE.

MESOCHAETE GRANDIRETIS Dix. sp. nov.

M. undulatae Lindb. peraffinis et similis; differt tantum cellulis *distincte majoribus,* 20-25 μ latis, omnibus subaequalibus.

Hab. Platypus Creek, 3 Jan., 1936; coll. H. Flecker (1225), type. Burrows Creek, 21 Sept., 1936; coll. H. Flecker (2551). Barron Gorge, 3 July, 1936; coll. S. Egan (1932).

This differs from *M. undulata* only in the constantly larger cells. In three specimens of *M. undulata*, I find them constantly from 8μ to 13μ in width. It might be suggested that the Queensland is a diploid form, but in that case one would expect other parts of the plant to share the increase in size, but this is not the case.

Whether both species occur in Queensland is uncertain. Watts & Whitelegge record *M. undulata* for Queensland, but it is quite probable that the size of the cells may have been overlooked, and that the plants may belong to the present species.

RHIZOGONIUM SPINIFORME (Hedw). Bruch.—Numerous gatherings.

RHIZOGONIUM PARAMATTENSE C.M.—Zerda Camp Clearing, Cairns, 4 Jan., 1936; coll. H. Flecker (1246). Campbell's Creek, 17 May, 1936; coll. H. Flecker (1673). Upper Mowbray R., 24 Nov., 1938; coll. Mrs. Sparvell (5890).

RHIZOGONIUM BREVIFOLIUM Broth.—On wood, Roots Creek, Feb. 1935; coll. T. Carr (344).

HYPNODENDRACEAE.

HYPNODENDRON ARCUATUM (Hadw.) Mitt. (Syn. *H. spininervium* (Hook.) Jaeg.).—Several gatherings.

MNIODENDRON COMATULUM Geh.—Mount Bartle Frere, 6 Oct., 1935; coll. H. Flecker (863).

This species is omitted, no doubt by accident, from the "Musci," by Brotherus. It is quite a good species.

BARTRAMIACEAE.

*PHILONOTIS IMBRICATULA Mitt.—Rocks in bed of North Toohey Creek, 23 May, 1937; coll. H. Flecker (3381). Granite rock, Fishery Creek, 16 Aug., 1936; coll. H. Flecker (2172). Banks of Campbell's Creek, 16 May, 1937; coll. H. Flecker (3298). All these gatherings show numerous axillary gemmiform brood bodies. Moist rocky bank in jungle, Freshwater Creek, 2 Oct., 1938; coll. H. Flecker (5253). An instructive plant. Some stems show the normal, acute-pointed leaves, with narrowish cells, while others have broad, more obtuse points, with decidedly lax cells, indicating an approach to *P. laxissima* (C.M.), which is, I feel assured, a derivative of *P. imbricatula*, and not a distinct species.

P. LAXISSIMA (C.M.) Bry. jav.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (43).

P. PSEUDO-MOLLIS (C.M.) Jaeg.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (42). Clay bank, Johnstone R., Innisfail, 17 May, 1936; coll. H. Flecker (1735). Jungle at intake, Mossman Gorge, 20 June, 1937; coll. H. Flecker (3498).

Very doubtfully distinct from *P. tenuis* (Tayl.).

*PHILONOTIS TENUIS (Tayl.) Jaeg.—Moist rocks, Tringilburra Creek, Cairns, 4 June, 1938; coll. H. Flecker (4760). Moist banks of Campbell's Creek, 16 May, 1937; coll. H. Flecker (3267).

These two plants represent a very lax-leaved form, with the stems prettily plumose. I have however similar forms from New Zealand,

where the species is common and very variable, and I have no doubt that they are only forms of it.

ERPODIACEAE.

WILDIA SOLMSIELLACEA C.M. & Broth.—Near Cogzell's Farm, Lower Tully, near Tully River, in jungle, Sept., 1937; coll. Miss E. Henry (4453). This curious, monotypic genus is only known from Queensland

CRYPHAEACEAE.

CRYPHAEA DILATATA H.f. & W. (Syn. *Cryphidium dilatatum* Broth. *Cryphaea Muelleri* Hampe).—Barron Gorge, 3 July, 1936; coll. S. Egan (2048).

CYRTOPODACEAE.

BESCHERELLEA CYRTOPUS F. Muell.—On trees, in jungle, Zarda Root's Creek track, 5 Jan., 1936; coll. H. Flecker (1285).

PTYCHOMNIACEAE.

HAMPEELLA PALLENS (Lac.) Fleisch.—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5943).

PTEROBRYACEAE.

TRACHYLOMA PLANIFOLIUM (Hedw.) Brid.—On bark of dead tree. Zarda Root's Creek track, Upper Mossman Creek; coll. H. Flecker, 5 Jan., 1936. (1291.)

ENDOTRICHELLA LEPIDA C.M.—On bark of tree, tributary of Tringilburra Creek, 29 May, 1938; coll. H. Flecker (4742). Upper Murray R., 12 Sept., 1938; coll. Mrs. Sparvell (5238.) The latter a form with short, almost obtuse-pointed leaves.

ENDOTRICHELLA DIETRICHIAE C.M.—Murray R., 5 Oct., 1937; coll. Mrs. Sparvell (3915). Round Beachview, Millaa Millaa, Oct., 1937; coll. Mrs. Sparvell (3955).

nov. var. LONGISETA Dix. Seta longior, thecam aequans. Theca exserta. Bark of tree, Tringilburra Creek, 29 May, 1938; coll. H. Flecker (4727).

In the type form, the seta is very short, shorter than the capsule, which is nearly hidden in the leaves. In the variety, the theca is well exserted above the leaves.

GAROVAGLIA LONGICUSPES Broth.—On trees, Roots Creek, 5 Feb., 1935; coll. T. Carr (342). This has probably not been collected since the original gathering at Rockingham Bay.

MUELLERIOBRYUM WHITELEGGEI (Broth.) Fleisch.—Josephine Creek, 2 June, 1935; coll. H. Flecker (560). Bank of Pine Creek, 2 Aug., 1936; (2073). Mossman Gorge, 8 Aug., 1936; (2112). On rocks, bank of Campbell's Creek, 17 May, 1936; (1650). All collected by H. Flecker.

METEORIACEAE.

PAPILLARIA CROCEA (Hampe) Jaeg.—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (6020).

PAPILLARIA FLEXICAULIS (Tayl.) Jaeg.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (45).

PAPILLARIA NITIDIUSCULA Broth.—On rachis of large pinnate leaf, Millaa Millaa, Sept., 1937; coll. Mrs. Sparvell (3891). Ibidem, 2 May, 1939 (5987b).

Brotherus appears to have omitted this from the 2nd Edition of the "Musci."

PAPILLARIA REGINAE (Hampe) Jaeg.—Millaa Millaa, Sept., 1937; coll. Miss E. Henry (3866, 3867).

METEORIUM MIQUELIANUM (C.M.) Fleisch.—Burrow's Creek, 21 Sept., 1936; coll. H. Flecker (2345). On rachis of large pinnate leaf, Millaa Millaa; coll. Miss E. Henry (3887).

*AEROBRYOPSIS LONGISSIMA (Doz. & Molk.) Fleisch.—In several gatherings, and showing much variation. I cannot separate it from the wide-spread and highly variable *A. longissima*. No. 172, collected by Miss Walsh at Butcher's Creek, is a slender, rather flaccid form, and might possibly be different.

METEORIOPSIS RECLINATA (C.M.) Fleisch.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (47).

NECKERACEAE.

CALYPTOTHECIUM ACUTUM (Mitt.) Broth.—North Toohey Creek, 23 May, 1937; coll. H. Flecker (3375). Bark of tree, in rain forest, Tully Falls, 1 Oct., 1939; coll. H. Flecker (6296).

CALYPTOTHECIUM SUBECOSTATUM Dix. sp. nov.

Late expansum, robustum, intense viride; caules 10 cm. et ultra, rigidi, laxe pinnati, ramis *horizontaliter divergentibus*, inaequalibus, *strictis, obtusis, dense foliosis*. Folia *fortissime undulata*, e basi lata maxime auriculata sensim angustata, late breviter acutata, versus apicem distanter inconspicue denticulata. Costa *perbrevis*, tenuis, tertiam partem folii vix attingens, *saepe nulla*. Fructus haud visus.

Hab. Corticolous, Tringilburra Creek, 29 May, 1938; coll. H. Flecker (4935).

A very distinct species in the habit, dense, very strongly undulate leaves, and almost or quite total absence of nerve.

NECKEROPSIS SPARVELLIAE Dix. sp. nov.

Paraphysanthus. Intense viridis, caules complanate ramosi, ramis valde divergentibus, *strictis, obtusis*. Folia complanata, madida *haud undulata*, sicca irregulariter foveolata, e basi latiore, uno latere (superiore) *late expanso, subauriculato*, altero late inflexo, decurrente, late oblonga, valde obtusa, rotundato-truncata, apiculo aut nullo aut brevissime obtuso, *indistincte crenulata vel subintegra*; costa latiuscula, superne raptim angustata et infra apicem desinens. Cellulae *minutae, opacae*, ovales, parietibus pellucidis; basilares elongatae, paullo laxiores, eae lateris inferioris omnes elongatae, pellucidiores, ad margines sat alte ascendentes, *limbum latum pallidiorem* instruentes.

Autoica. Perichaetia polyphylla, bractae externae late ligulata, internae setaceo-loriformes, denticulatae, thecam praelonge superantes. Calyptra pilosa.

Hab. Woolkoo, Murray R., 12 Sept., 1938; coll. Mrs. Sparvell (5237).

Differs from the New Guinea *N. nano-disticha* (Geh.) and the allied species in the leaves not transversely undulate, the minute, opaque cells, almost entire apex, pilose calyptra, etc.

*HOMALIODENDRON DENDROIDES (Hook.) Fleisch.—Millaa Millaa, Miss E. Henry, Sept., 1937; (3894).

This appears to be new to Australia. Its distribution is Pacific, from New Caledonia to Hawaii.

LEMBOPHYLLACEAE.

*CAMPTOCHAETE ARBUSCULA (Hook.) var. *deflexa* (Wils.) H.f. & W. —On stem of twining creeper, Beachview, Millaa Millaa, 5 Oct., 1937; coll. Miss E. Henry (3964).

CAMPTOCHAETE RAMULOSA (Mitt.) Jaeg.—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5932). A soft, lax form.

CAMPTOCHAETE GRACILIS (H.f. & W.) Par.—Lochaber Creek, near Eidsvold, April, 1932; coll. T. V. Sherrin (48).

This species has not been credited to Queensland, but it exists in herbaria under another name, viz., *Lembophyllum brisbanicum* C.M. This appears to be an unpublished name. I have seen no original specimen, but I have two specimens from New South Wales, collected by W. W. Watts, and so named on the authority of Brotherus. Obviously from the specific name the plant determined by C. Mueller must have been from near Brisbane.

C. gracilis differs from the other species of the genus in the habit, which is rarely dendroid. (Brotherus denies it the dendroid habit altogether, but I have some plants which show this habit quite distinctly. It is a most variable plant in many directions, the leaves may be obtuse, bluntly acute, or apiculate; they may be entire or faintly denticulate, and the nerve may be (usually) wanting, very faint and single, or short and double.

*LEMBOPHYLLUM CLANDESTINUM (H.f. & W.) Lindb.—Mount Bartle Frere, 5 Oct., 1935; coll. H. Flecker (844). Jungle at intake, Mossman, 20 June, 1937; coll. H. Flecker (3502). Both these show some difference from the usual form, having a very rigid habit, tapering branches, and apiculate leaves.

HOOKERIACEAE.

CALLICOSTELLA RUGISETA Dix. sp. nov.

Atrofusca, subnitida, tapete late expansum instruens; stricta, ramis haud complanatis. Folia oblonga, fusco-purpurea, acuta, versus apicem *dense, validiuscule bigeminatim serrulata.* Costae fuscae, dorso dentato. Cellulae ellipticae, parietibus *firmis,* subincrassatis, superiores *acute papillosae.*

Dioicum videtur. Seta 1 cm. vel paullo ultra, crassiuscula, per totam longitudinem *grosse tuberculato-papillosa.* Theca suberecta, oblonga. Peristomium magnum, aurantiacum.

Hab. Rocks at edge of stream of Campbell's Creek, 19 Sept., 1937; coll. H. Flecker (3844).

Distinct in the colour, habit, acute, densely bigeminately serrulate leaves, and rough seta. *C. Kaernbachii* Broth. has a similar seta, but the leaves are described as obtuse, and different.

HYPOPTERYGIACEAE.

HYPOPTERYGIUM (LOPIDIUM) DAYMANNIANUM (Broth. & Geh.) Broth.—Millaa Millaa, on wood, May, 1939; coll. Mrs. Sparvell (5992, 5998, 6006). On small trees in rain forest, Mt. Spec, Jan., 1940; coll. Miss E. Henry (6753).

A very distinct and pretty species.

HYPOPTERYGIUM MUELLERI Hampe.—Round Beachview, Millaa Millaa, 5 Oct., 1937; coll. Miss E. Henry (3960). Track near Falla, on rotten log, Mt. Spec, Jan., 1940; coll. Miss E. Henry (6734).

The variation in the denticulation of the leaves and amphigastria is so great that I can find no distinct line of demarcation between this and *H. Scottiae*, and I incline to think they are not specifically distinct. I do not know of any other distinguishing characters.

RHACOPILACEAE.

RHACOPILUM CONVOLUTACEUM C.M.—Lochaber Creek, near Eidsvold, Apr., 1922; coll. T. V. Sherrin (51, 52).

*RHACOPILUM CRISTATUM H.f. & W.—Mt. Bartle Frere, covering a boulder, 29 Nov., 1936; coll. H. Flecker (2629).

THUIDIACEAE.

*CLAOPODIUM ASSURGENS (Sull. & Lesq.) Card.—Barron Gorge, 3 July, 1936; coll. S. Egan (1941). New to Australasia. Distr. wide in India and Indo-Malaya.

THUIDIUM SPARSUM (H.f. & W.) Jaeg.—In large, dense mats, Millaa Millaa, Sept., 1937; coll. Miss E. Henry (3901A). With a few capsules. The fruit is rare.

THUIDIUM FURFUROSUM (H.f. & W.) Jaeg.—Barron Gorge, 3 July, 1936; coll. S. Egan (2100).

THUIDIUM PLUMULOSIFIRME (Hampe) Jaeg.—Mt. Bartle Frere, covering a rock, 29 Nov., 1936; coll. H. Flecker (2650). Murray R., 5 Oct., 1937; coll. Mrs. Sparvell (3913). Ibidem, 12 Sept., 1938 (5233). All these are lax forms, both as regards the branching and the foliation.

BRACHYTHECIACEAE.

RHYNCHOSTEGIUM PATULUM (Hampe) Jaeg.—North Cedar Creek, Ravenshoe, 23 Dec., 1938; coll. T. V. Sherrin (5486).

I determine this from the description. I have not seen specimens.

RHYNCHOSTEGIUM INAEQUALE Dix. sp. nov.

Viride vel luteo-viride; sat robustum; caules prostrati, sat regulariter pinnatim ramosi, ramis supra descrescentibus. Axis caulis *crassus*. Folia patentia, complanatula, sicca paullo contracta et flexuosa; 2 mm. longa, late ovata, acute acuminata, *asymmetrica* (uno margine fortiter, altero parum convexo), apice saepe semitorto, *subintegro vel parce denticulato*. Costa *debilis*, plerumque medium folium attingens, *ad latus minus convexum propinquior*. Cellulae elongatae, sigmoideae, versus basin laxiores, infimae 1-2-seriebus *multo latioribus*, pellucidae.

Fructus ignotus.

Hab. North Cedar Creek, Ravenshoe, 23 Dec., 1938; coll. H. Flecker (5486).

Fairly distinct in the asymmetrical leaves, almost entire, with the nerve much nearer to the less convex margin.

ENTODONTACEAE.

ENTODON TERRAE-REGINAE Dix. sp. nov.

obustus, *pallide stramineus, nitidissimus*. Rami *stricti*, plerumque obtusi, subcomplanati; folia imbricata, concava, ovata,

peracuta, saepe acuminata, superne *distincte denticulata*; cellulae latiusculae, inferne latiores, alares multae.

Cetera ignota.

Hab. North Toohey Creek, 23 May, 1937; coll. H. Flecker (3376).

Although without fruit this belongs without doubt to the small group of species of which *E. pallidus* Mitt. is the best known. It is more robust and more rigid than that species, with less julaceous leaves, which are distinctly denticulate above and sometimes nearly all round, which characters bring it still further from *E. mackaviensis* C.M.

ENTODON MACKAVIENSIS C.M.—Lochaber Creek, near Eidsvold, Apr., 1922; coll. T. V. Sherrin (49).

SEMATOPHYLLACEAE.

ACANTHOCLADIUM EXTENUATUM (Brid.) Mitt.—This is a rather common moss, and very variable. One of the more frequent forms is the slender, rather rigid plant with the cells distinctly seriately papillose, which has figured more than once at a Taxithelium.

ACANTHOCLADIUM RIGIDIFOLIUM Dix. sp. nov.

§Acanthocladiopsis. Pallide viride, intus stramineum, *rigidiusculum* gracile. Caulis 3-4 cm. longus, sat dense *bipinnatus,* ramis et ramulis subcurvatis. Folia omnia *subsimilia, stricta,* erecta vel patula, sicca parum mutata, convoluta, erectiora, 1-1·5 mm. longa, brevia, e basi *subcordata deltoideo-ovata, breviter, late, acute acuminata,* superne *dense, argute,* sat regulariter, *subaequaliter* serrulata, ecostata; cellulae breviusculae, anguste lineares, inferne laxiores, alaribus numerosis, magnis, hyalinis vel flavidis, oblongis vel subquadratis, *parietibus tenuibus,* alas majusculas, bene notatas instruentes. Folia ramea et ramulina minora, brevius, latius acuminata, nonnunquam subobtusa, argutius serrata.

Fructus ignotus.

Hab. Lochaber Creek, near Eidsvold, Apr., 1922; coll. T. V. Sherrin (9).

Distinct, from the Australasian species at least, in the rather rigid, bipinnate stems, and broadly, shortly-pointed leaves, which bring it, so far as can be determined from the sterile plant, under the Section Acanthocladiopsis, hitherto known only from Africa and Japan.

MEIOTHECIUM WATTSII Broth.—Near Cairns, 1 Aug., 1938; coll. A. Glindeman (5077).

ACROPORIUM ERYTHROPODIUM (Hampe) Broth.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (60).

ACROPORIUM SCALARIRETE Dix. sp. nov.

Laete virens, gracile, humile. Caulis brevis, *dense pinnatus,* ramis brevibus, saepe cuspidatis. Folia conferta, patentia, circa 2 mm. longa, concava, *cordato-lanceolata,* integerrima, *breviter acute cuspidata,* apice convoluto; cellulae pulchre chlorophyllosae, *angustissimae, incrassatae,* laeves, alares subito *magnae, multae, subquadratae,* pulchre aurantiacae *scarales, fortiter incrassatae.*

Cetera ignota.

Hab. Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5935).

A small, bright green plant, with much the habit of *A. erythropodium* (Hampe), but with narrower leaves of quite unique structure, the alar cells being numerous, subquadrate, scalariform in several series, in fact exactly as in Dicranum; they are however highly incrassate with very narrow lumen.

*SEMATOPHYLLUM CALLIFERUM (Geh. & Hampe) Broth.—Duma Creek, Ravenshoe, Summer, 1922; coll. T. V. Sherrin (57). I name this with some doubt. The toothed leaves and perichaetial leaves agree, but the seta is much thinner than it should be.

*SEMATOPHYLLUM CALLIDIOIDES (Hampe & C.M.) Jaeg.—Dead twig in jungle, Zarda Roots Creek track, 5 Jan., 1936; coll. H. Flecker (1299A).

This too is not quite certain. The leaves are often rather too abruptly subulate, as in Warburgiella.

SEMATOPHYLLUM SAPROXYLOPHILUM (C.M.) Broth. forma robusta.—Upper Mowbray R., June, 1938; coll. Mrs. Sparvell (4948, 4949). This is evidently the form recorded by Watts from Frenchman's Creek.

SEMATOPHYLLUM CAESPITOSUM (Sw.) Mitt.—Lower Tully, in jungle, Sept., 1937; coll. Miss E. Henry (4454).

SEMATOPHYLLUM ACICULUM (C.M.) Dix.—Lochaber Creek, near Eidsvold, Apr., 1922; coll. T. V. Sherrin (55).

TRICHOSTELEUM HAMATUM (Doz. & Molk) Jaeg.—On bark of tree, Tringilburra Creek, 4 June, 1938; coll. H. Flecker (4763).

TRICHOSTELEUM PALLIDUM Dix. sp. nov.

Humillimum, condensatum, *albescens,* pinnatum. Folia undique patentia, haud complanata, sicca flexuosa, *paullo falcata,* parva, sericea; e basi vix constricta *anguste oblongo-lanceolata,* concava, *inde sensim tenui-acuminata, filiformia, integerrima*; cellulae pellucidae, *angustissimae,* nunc omnino laeves, nunc *sparse, acute, spiculose unipapillatae.* Alares magnae, tenerae, vesiculosae.

Autoicum. Perichaetii folia caulinis similia sed majora, longiora, sensim longe filiformia, denticulata. Seta circa 1 cm., laevis. Theca pendula, *minuta,* vix ·5mm longa, ovata, pallida; operculum brevirostratum.

Hab. Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (59).

A distinct, pretty little species, very pale in colour; *T. elegantulum* Broth. & Watts has broader, toothed leaves, a roughish seta, and the capsule "majuscula"; here it is very minute.

TAXITHELIUM KERIANUM (Broth.) Broth.—Near Tully River, Lower Tully, in jungle, Sept. 1937; coll. Miss E. Henry (4452).

TAXITHELIUM NOVAE-VALESIAE (Broth.) Broth.—Upper Mowbray R., 11 Nov., 1938; coll. Mrs. Sparvell (5879). On dead wood, track to falls, near Mt. Spec, Jan., 1940; coll. Miss E. Henry (6739, 6740).

GLOSSADELPHUS DIMORPHUS Dix. sp. nov.

Corticola, pulchre viridis. Caulis *complanatus,* 2–3 cm. longus vel ultra, frondem circa 3 mm. latam instruens, *ramis paucis minutis.* Folia caulina patentia, sicca leniter longitudinaliter plicata, 1·5 mm. longa, ·75 mm. lata, *breviter late oblongo-elliptica, valde asymmetrica,* apice

rotundata, obtusissima; margines *plani,* superne minutissime crenulato-denticulati. Costa nulla. Cellulae superiores *lineari-fusiformes,* elongatae, laeves, parietibus tenuibus, inferne *sensim longiores,* parum latiores, basilares et alares vix mutatae, omnes valde chlorophyllosae. Folia ramea *multo minora,* late obtuse acutata, *argute denticulata,* Cetera nulla.

Hab. On twining shrub, Millaa Millaa, 5 Oct. 1937; coll. Miss E. Henry (3964b).

A single stem, with *Camptochaete arbuscula.*

Except for *Ectropothecium serrifolium* Broth. and Watts, which was placed later by Brotherus in Glossadelphus, and in my opinion a rather doubtful alteration, this is the only Australian species of this rather unsatisfactory genus. It is very marked in the complanate, broadly oblong, very obtuse stem leaves, and the very small, almost microphyllous branches, having small, more or less pointed, serrulate leaves.

MACROHYMENIUM MITRATUM (Doz. & Molk.) Fleisch. [Syn. *M. rufum* (Reinw. & Hornsch.) C.M.]—Millaa Millaa, 2 May, 1939; coll. Mrs. Sparvell (5964).

HYPNACEAE.

*HYPNUM CUPRESSIFORME Hedw. var. filiforme Brid.—Millaa Millaa, Sep. 1937; coll. Miss E. Henry (3881).

HYPNUM SUBCHRYSOGASTER (Broth.) Broth.—Upper Mowbray R., 31 May, 1939; coll. Mrs. Sparvell (6166).

ECTROPOTHECIUM SODALE (Sull.) Mitt.—Endeavour R., Queensland, 1883; coll. W. A. Persieh; herb. W. Mitten.

*ECTROPOTHECIUM MORITZII (C.M.) Jaeg.—Majuba Falls, Mt. Bartle Frere, 29 Nov. 1936; coll. H. Flecker (2658). I have also a specimen of this from Sydney, N.S.W., coll. Rev.-Collie, ex herb. Mitten. It was sent unnamed from the New York Bot. Garden. I cannot separate these plants from the Malayan species, though it is rather surprising that it has not been recorded from the intermediate regions, e.g., New Guinea.

ECTROPOTHECIUM UMBILICATUM (C.M.) Jaeg.—Rain forest, Mt. Tyson, 16 Feb. 1939; coll. H. Flecker (5665).

ECTROPOTHECIUM SERRIFOLIUM Broth. & Watts.—On tree roots over waterfall, Root's Creek, near Monamona Mission Station, 8 Oct. 1939; coll. H. Flecker (6295). On granite boulder, stream of Fishery Creek, 16 Aug. 1936; coll. H. Flecker (2164).

ISOPTERYGIUM TAXIRAMEUM (Mitt.) Jaeg.—(Syn. *Isopterygium robustum* Broth.)—Surface of rock in jungle, Smithfield range; coll. H. Flecker (3403). *I. robustum* Broth. is surely the same thing; it is a slightly robust form only.

Fleischer and Brotherus say of this wide-spread species that it has the leaves spiculose at the back with the prominent cell ends. I have never detected this, and have no doubt it is an error of observation. Mr. Bartram agrees with me in this.

ISOPTERYGIUM AUSTRO-PUSILLUM (C.M.) Jaeg.—Murray R., 5 Oct., 1937; coll. Mrs. Sparvell (3911). Cogzell's Farm, Lower Tully, near

Tully R., in jungle, Sept., 1937; coll. Miss E. Henry (4454). Tringilburra Creek, May, 1938; coll. H. Flecker (4764).

ISOPTERYGIUM CANDIDUM (C.M.) Jaeg.—Woolkoo, Upper Murray, 12 Sept. 1938; coll. Mrs. Sparvell (5242). This seems to agree quite well with the species, except that the colour is not whitish, but bright green. I think it is only a form of this species. I much doubt if it be distinct from the Pacific *I. molliculum* (Sull.).

POLYTRICHACEAE.

*PSILOPILUM AUSTRALE (H.f. & W.) Jaeg.—Hillcrest, Millaa Millaa Rd., Cairns, 28 June, 1938; coll. H. Flecker (4902). Not, I think, known from Queensland. Its most northerly record.

DAWSONIA LONGISETA Hampe.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (63).

DAWSONIA POLYTRICHOIDES R. Br.—Duma Creek, Ravenshoe, 1922; coll. T. V. Sherrin (62).

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THE DEVONIAN TABULATA OF DOUGLAS AND DRUMMOND CREEKS, CLERMONT, QUEENSLAND.

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(PLATES I.-III.)

(*Communicated to the Royal Society of Queensland by D. Hill, M.Sc., Ph.D., 28th April, 1941.*)

SUMMARY:

This paper is a companion to a paper on the Rugose corals of this district published by Dr. Dorothy Hill in the Proceedings of the Society in 1939. It describes the Tabulate Corals collected by her and those in the collection of the Geological Survey of Queensland. The following genera and species are recorded and described:—

Favosites Lamarck .. .. p. 42
Favosites bryani Jones .. .. p. 42
Favosites nitidus Chapman .. .. p. 43
Alveolites Lamarck .. .. p. 43
Alveolites suborbicularis Lamarck .. .. p. 44
Thamnopora Steininger .. .. p. 45
Thamnopora meridionalis (Eth.) var. *minor* var. nov. .. p. 47
Thamnopora foliata sp. nov. .. .. p. 48
Striatopora Hall .. .. p. 49
Striatapora ? hillae sp. nov. .. .. p. 50
Striatopora ? plumosa, sp. nov. .. .. p. 51
Gephuropora Etheridge .. .. p. 51
Gephuropora duni Etheridge .. .. p. 54
Scoliopora Lang, Smith & Thomas .. .. p. 55
Scoliopora flexa sp. nov. .. .. p. 56
Syringopora Goldfuss .. .. p. 57
Syringopora cf. spelaeanus Etheridge .. .. p. 57

Thamnopora meridionalis (Etheridge) although not occurring in the area is redescribed (p. 46) to facilitate the description of the new variety. The species of *Scoliopora* is the first record of that genus for Australia and *Gephuropora duni* is recorded for the first time from Queensland.

Age of the Limestones: Dr. Hill in her paper gave a summary of the previous work to which account the reader is referred, and determined the age by the *Rugosa* to be Lower Middle Devonian and probably the upper part of the Lower Middle Devonian, i.e. Upper Couvinian.

All the species of Tabulata are purely Australian. *Favosites bryani* occurs in the Receptaculites Limestone at Yass, which is fairly high in the Couvinian, and in the probably Lower Devonian Garra beds near Molong. *F. nitidus* occurs at Deep Creek and Cooper's Creek, Walhalla, Victoria, which is Upper Silurian [? Devonian]. *Alveolites suborbicularis* occurs throughout the Devonian of Europe. *Thamnopora meridionalis* var. *minor* is close to *T. meridionalis* from the Upper Middle

Devonian Burdekin beds and is also close to an undescribed species from the Middle Devonian of Buchan, Victoria. *Thamnopora foliata* occurs in the Couvinian of Silverwood, Queensland, *Striatopora? hillæ* and *Striatopora? plumosa* are not closely comparable with any decsribed species and though in size of the coralla they approach the Upper Silurian *S. halli*, little weight can be placed on such a comparison. *Gephuropora duni* occurs in the Bluff limestone (base of Couvinian) and the Currajong limestone (400 feet above the Bluff) at Taemas, N.S.W., and also in the Middle Devonian of Buchan, Victoria. Of the European species of *Gephuropora* described by Lecompte it is closest to *G. mailleuxi* which occurs in the middle and upper part of the Couvinian *Scoliopora flexa* is not clearly comparable with any described species, but species of this genus occur in the Givetian and Frasnian of Belgium and in the Devonian of Germany. *Syringopora spelaeanus* occurs in the Couvinian of Wee Jasper, N.S.W. and *S. eifelensis*, which it closely resembles occurs in the Upper Couvinian and Lower Givetian of Europe.

The age then is clearly Couvinian but it is difficult to place it more closely, as only one of the species, *Alveolites suborbicularis*, occurs outside Australia. But the relationship of *Gephuropora duni* and *Syringopora spelaeanus* with European species together with the general assemblage suggest it to be the upper part of the Couvinian. This is in agreement with Dr. Hill's determination based on the Rugosa.

MADREPORARIA TABULATA.

FAMILY FAVOSITIDAE.

Genus FAVOSITES Lamarck.

Favosites Lamarck 1816, p. 204; Smith and Gullick, 1925, p. 117; Jones, 1936, p. 2.

Genotype: F. gothlandicus, Lamarck, 1816, p. 205. Silurian of Gotland.

FAVOSITES BRYANI Jones.

Pl. I, Fig. 1.

Favosites bryani Jones 1937; pp. 96, 97; pl. xv. figs. 3-6.
Favosites bryani Hill and Jones 1940; p. 190; pl. v, figs. 2a, 2b.

Holotype: (by original designation). The specimen in the Australian Museum F. 5550 from the Middle Devonian of Good Hope, Yass, N.S.W.

Diagnosis: Favosites with small moderately thick walled polyhedric corallites, long, slender, sharply pointed septal spines, one row of circular mural pores, and fairly numerous tabulae, which are mostly complete.

Description of Clermont Specimens: All consist of fragments of colonies—flat pieces of small thickness, probably exfoliation flakes, so that the external form is unknown. The corallites have a diameter of 1 to 1·25 mm., the walls are moderately thick; long sharply pointed septal spines show in the longitudinal section. The mural pores have been observed in only one place where they are in two rows. The tabulae are numerous, mostly complete some incomplete and inosculating about 15 in a space of 5 mm.

Remarks: The Clermont specimens agree well with the holotype and other Taemas material except that in the Clermont specimens the mural pores in the only place where they can be seen are in two rows. In the Taemas material they are usually in one row but occasionally in two.

Locality: Douglas Creek, Clermont (Univ. of Q. collection, F. 3964) and probably Geol. Surv. of Q. collection, 66. F. 3965-6 (Univ. of Q. collection) are placed in this species on macroscopic characters.

FAVOSITES NITIDUS Chapman.

Pl. I, Fig. 2.

Favosites nitida Chapman 1914, p. 309, pl. liv, figs. 21-23; pl. lv, figs. 24, 25.

Favosites nitida Jones, 1937, p. 93, pl. xiii, figs. 4, 5.

Favosites nitidus Hill & Jones, 1940, p. 198, pl. vi, figs. 3a-c.

Diagnosis: Favosites with small, erect polyhedric corallites, blunt septal spines which are very irregularly distributed and may be entirely absent in parts of the corallum, one row of large circular mural pores and fairly numerous complete tabulae.

Remarks: Two specimens from Clermont are quite typical of the species. Septal spines are numerous. A third badly preserved specimen is doubtfully included.

Locality: South Limestone belt, Clermont, Por. 73, Par. Copperfield (F. 3967, F. 3968 University of Queensland Collection, collected by D. Hill). The doubtful specimen is in the Geological Survey of Queensland Collection, No. 21, and is from Douglas Creek, Clermont. F. 3969-81 (Univ. of Q. collection) are placed in this species on macroscopic characters.

Genus ALVEOLITES Lamarck.

Alveolites Lamarck, 1801, p. 375.
Alveolites Smith, 1933, p. 135.
Alveolites Lecompte, 1933, p. 7; 1939, p. 17.
Alveolites Hill, 1936, p. 33.

Genolectotype: Alveolites suborbicularis Lamarck, 1801, p. 376. Upper Devonian, Frasnian. Near Dusseldorf, Germany. See Smith 1933, p. 135.

Diagnosis: Massive, ramose or encrusting Tabulate corals, frequently growing in superimposed layers. The corallites grow out horizontally from one or more centres or diverge from an axis. Usually the corallites are small, semilunular or sub-triangular in section; they are more or less compressed, and open to the surface by oblique calices, each with lower lip projecting. The wall may be thin or dilated; the septa when present are represented by spines. The tabulae are complete and thin, and the mural pores are wide and distant. (Emended from S. Smith, 1933, p. 135.)

Remarks: The genus *Alveolites* has recently been discussed by Lecompte 1933, 1939; Smith 1933, and Hill 1936. Lecompte dealing with a wealth of material has described the variation in each species and Miss Hill has made the first observations on the microscopic structure of the skeleton, basing these on material from the Eifel and Western Australia.

My observations on the single specimen from Clermont confirm that the fibres of the wall diverge from the "median dark line" which is median or almost so in those corallites which are more erect and sub-polygonal in section, and commonly sub-median in those which are reclined and semilunar in section. But contrary to Miss Hill's observations on the Eifel material, when sub-median it is more commonly nearer to the upper surface of the wall, though frequently nearer to the lower surface. My observations on a specimen from Torquay are similar. The fibres cannot be seen in longitudinal section nor can the structure of the septal spines. In the Clermont specimen the wall where cut tangentially shows in two places hints of the streaky appearance described below (p. 52) and thought to be due to the septa having exceedingly short lamellar bases, but it cannot be regarded as certain.

ALVEOLITES SUBORBICULARIS Lamarck.

Pl. I, fig. 3.

Alveolites suborbicularis Lamarck, 1801, p. 376.

Alveolites suborbicularis Smith, 1933, pp. 137-138.

Alveolites suborbicularis Lecompte, 1933, pp. 15-25; 1936, pp. 6-9; 1939, pp. 19-22.

Alveolites suborbicularis Hill, 1939 (b), p. 145.

Neotype: (chosen by Smith, 1933, p. 138). The original of *Calamopora spongites* var. *tuberosa* Goldfuss, 1829, pl. xxviii, figs. 1a-b; Upper Devonian of Bensberg, near Cologne, in the Goldfuss Collection, Bonn University. (Lecompte 1936, p. 7 and pl. 1, fig. 1a, described and figured this specimen as the original of fig. 1d of Goldfuss; it is clearly the same specimen as cited by Smith since Lecompte's fig. 1a, pl. 1 is identical with Smith's figs. 1 and 2, pl. 11).

Diagnosis: *Alveolites* whose small corallites have thick or thin walls and are semi-lunar, sub-triangular or rarely sub-polygonal in section; septal spines absent or represented in some corallites by a a vertical row of strong spines or by a number of rows of small spines; mural pores uniserial, confined to the small sides of the corallites. (Based on Smith, Hill and Lecompte).

Description of the Clermont Specimen: The corallum is encrusting on a colony of *Gephuropora* and is 6 cm. by 6 cm. by 2 cm. high. The corallites diverge from a number of centres. The corallites are almost all reclined and in section are semi-lunar, rarely sub-triangular or sub-polygonal, 0·6-0·9 mm. in their longer and 0·6-0·5 in their shorter direction. The dilatation of the walls varies in different parts of the corallum, in places it is considerable (0·3 mm.) in other places slight (0·1 mm.). Septal spines are developed irregularly, some corallites showing none at the level of the sections, others as many as five; the spines are short and rather thick, single strong spines not observed.

The mural pores are uniserial, usually at the lower angles of the corallites, of the order of size of 0·15 mm. diameter. The tabulae are not numerous, very irregularly distributed, as far apart as 2 mm. and as close as 0·2 mm.; they are complete, most usually horizontal but frequently inclined.

Remarks: Lecompte (1939, pp. 9-16) has made a valuable study of variation in species of Tabulate corals and indicates the limits of variation he considers permissible in a species. In the same work

(pp. 22-23) he divides *A. suborbicularis* into three *formae* on the type of corallum. Accepting this division into formae the specimen described above would be placed in forma *gemmans* (p. 22, pl. 1, figs. 1-12). Whether this division into formae can be applied to Australian material must await further collection and examination.

In size of corallites the Clermont specimen is slightly smaller than the holotype, but Lecompte (1933) studying a wide range of material gave 12 to 17 corallites in a distance of 10 mm. in a longitudinal direction and about 20 in a transverse direction. Smith, studying the syntypes, concluded that septa are represented by one vertical row of spines, but Lecompte, studying both syntypes and other material, concluded that they are represented by small granular spines in vertical rows but that the median spine on the lower face is often larger than the others which do not appear in all corallites of any one section.

In the Clermont specimen the septal spines appear most frequently as dots (cross sections) in the longitudinal section, although they are present in several corallites in the transverse section. I was in some doubt whether these dots and projections were spines or due to recrystallisation, but in some the yellowish tinge characteristic of dead coral tissue can be observed, so that some if not all are spines. The most observed in one corallite in transverse section was five while Lecompte observed as many as eight in a paratype (1936, p. 8).

The number of tabulae varies greatly both in different specimens and in different parts of the same specimen. For the holotype Smith says they are less than 0·5 mm. apart. Lecompte says usually 25 in 10 mm., but that he observed up to 4 in a mm. in which case they were very regularly spaced. This then is a point in which the Clermont specimen differs from the European material for in it the tabulae are very irregularly spaced, varying from 2 mm. apart to 0·2 mm. apart.

Locality: Por. 73, Par. Copperfield, Clermont, Queensland (Univ. of Q. coll. F. 3959).

Genus THAMNOPORA Steininger.

Thamnopora Steininger, 1831, p. 10.

Pachypora Lindstrom, 1874, p. 14.

Thamnopora Hill, 1937, p. 56.

Genotype: Alveolites cervicornis de Blainville, 1830, p. 370, Middle Devonian, Eifel.

Diagnosis: Ramose or laminar Tabulate corals in which the cylindrical branches may be flattened and coalesced, the corallites are typically polygonal, and diverge from the axis of the branch and usually open normally to the surface; the corallite walls are dilated throughout, and the dilatation increases distally, typically the growth lamination in the sclerenchyme of the wall is obvious, while its fibrous nature is not; septal spines may or not be present and mural pores are usually large. (Emended from Hill 1937, p. 56.)

Remarks: For synonomy and genolectotype see Hill, 1937, p. 56. Lindstrom, 1874, founded the genus *Pachypora* for a Silurian species, *P. lamellicornis* from Visby, Gotland. Later writers put other species including *Alveolites cervicornis* de Blainville, the genotype of *Thamnopora* in this genus. Lindstrom, 1896, disagreed with them stating that the structure of the sclerenchyme in *Pachypora* was essentially different

from that in other genera of the Favositidae. Hill, 1937, regarded *Pachypora* as a synonym of *Thamnopora*, observing that the growth lamination obscured the fibrous nature of the walls. Lecompte, 1936 pp. 9-34, examined the type of "*Favosites*" *cervicornis* (which afterwards in 1939, he referred to *Thamnopora*) and specimens of Lindstrom's own material of *P. lamellicornis*. He figured thin sections of the walls of both, some highly magnified, and discussed the wall structure in detail. He concluded, p. 30, that probably *Pachypora* is distinct from *Thamnopora* on the basis that the structure of the sclerenchyme in *Thamnopora* is a layer with a structure "en barbes de plumes," i.e., like the feathers of a quill, and another layer with a radiating fibrous structure, while the structure in *Pachypora* is finely laminated concentric to the calices.

I have had the opportunity of examining only a few sections of *T. cervicornis* but after careful study of Lecompte's reasoning and of his excellent plates and study of thin sections of topotypes of *P. lamellicornis* I am of the opinoin that there is no essential difference between the structure of the two genera, that while the structure in *P. lamellicornis* is finer than in *T. cervicornis* both are produced by recrystallisation making the growth laminae more conspicuous than the fibrous trabecular structure, and that this suppression of the fibrous structure has proceeded further in *P. lamellicornis*. This is the interpretation expressed by Miss Hill, 1937, p. 56, and in correspondence with M. Lecompte but is not accepted by the latter.

An important paper by Bryan and Hill, 1941, shows this interpretation to be correct. They show that in Hexacorals the mechanism of growth is spherulitic, each trabecula of the vertical skeletal elements and each horizontal element being a spherulite, plumose and pilose aggregates respectively. They point out, further, that while the skeleton of the Rugosa, the Tabulata and Heliolitida are calcite and were presumably deposited as calcite (not aragonite as in the Hexacorals) they are fibrous and their septa trabeculate and thus it may safely be assumed by analogy that their skeletons were produced by spherulitic crystallisation. Two types of concentric lamellar banding, which interrupt the fibres, were observed by them in Hexacorals, the larger, more conspicuous and less regular of which they consider due to irregular growth of the organism, and the smaller, more delicate and remarkably regular alternations as due to rhythmic deposition of skeletal material, the rhythm being induced by alternate periods of quiescence and active feeding during the hours of daylight and darkness.

Thus *Thamnopora* must originally have had a fibrous structure in common with the rest of the Tabulata, and it is easy to understand that recrystallisation would obscure that structure so that the rhythmic lamination would be relatively more prominent.

At Clermont two species of *Thamnopora* occur. One of these is close to *T. meridionalis* (Nicholson and Etheridge). As no description of the latter has appeared since 1892 and as I have had the opportunity of examining some of Etheridge's original material, the species is redescribed and figured here:

THAMNOPORA MERIDIONALIS (Nicholson and Etheridge).

Pl. I, figs. 4-6.

Pachypora meridionalis Nicholson and Etheridge 1879, p. 280, pl. xiv, figs. 4-4c. Etheridge 1892, p. 51, pl. 2, figs. 10-15.

Syntypes: Nicholson and Etheridge's syntypes are in the British Museum (Natural History) Nos. 90239a, b, 90241 and are unobtainable at the present time owing to the European war. The species is interpreted here on specimens which were figured with the syntypes by Etheridge, 1892, on other specimens named by Etheridge, and additional material from Burdekin Downs. These specimens are in the collection of the Geological Survey of Queensland, F. 1645 (Etheridge fig. 15), F. 1651 (fig. 14), D_3 and D_6 (sections only) and in the collection of the University of Queensland. Another specimen apparently named by Etheridge is labelled D_3 but is not the one from which the section D_3 was cut. It is excluded from *T. meridionalis* as it is a much larger form.

Diagnosis: Thamnopora branching dichotomously at distant intervals, with small corallites, no septa, few but large mural pores and few but complete tabulae.

Description of Etheridge's Specimens: The two figured specimens differ in the diameter of the branches, one being 2 mm., the other 8 mm. All the coralla are embedded in limestone. Dichotonous branching can be observed in one place. The sections show the diameter of the corallites to be about 0·5 mm. in the axial region, increasing rapidly when the corallites diverge towards the surface of the coralla, to reach a diameter of 0·75 mm. at the calices. The diameter of the calices is greatly reduced by thickening and their original polygonal outline is not always discernible. The calices are only slightly oblique, opening almost at right angles to the surface. The corallite walls are thickened throughout, slightly in the axial region, but the thickening increases rapidly towards the calices. Septa are absent. Mural pores are rare and apparently irregularly disposed. They are placed in the walls of the corallites, are circular and large. The tabulae are few, irregularly distributed, thin, complete, sometimes 0·5 mm. apart.

Remarks: Nicholson and Etheridge record this species from the Fanning River, Burdekin Downs, Arthur's Creek (Burdekin Downs), and Regan's, Northern Railway; Middle Devonian. A variety (described below) occurs at Clermont.

T. meridionalis is very close to *T.* (?) *vermicularis* (McCoy) as described and figured by Lecompte 1939. In the latter, however, the calices are smaller and very oblique, characters in which the Clermont variety resembles it more closely. *T. meridionalis* is smaller than *T. dubia* (de Blainville).

THAMNOPORA MERIDIONALIS: (Nicholson and Etheridge).

var MINOR var. nov.

Pl. I, figs. 7.

This variety differs from *T. meridionalis* in branching more frequently; the average diameter of the branches appears smaller, some being as small as 1·5 mm., while the largest observed is 6 mm. wide and 2 mm. thick, but about 2 mm. is the most usual; branches are more frequently flattened; the calices are much more oblique being like those of *T.* (?) *vermicularis* in this respect. The diameter of the corallites is also smaller, being 0·25 mm. in the axial portion and almost 0·5 mm. at the calices. This variety is also very like an undescribed form from Buchan, Victoria, but in the latter the corallites open almost at right angles to the surface.

Locality: Por. 73, Par. Copperfield, Clermont. (F. 4039, F. 4044, F 4045, University of Queensland collection.)

THAMNOPORA FOLIATA sp. nov.

Pl. II, figs. 1-3.

Pachypora meridionalis Richards and Bryan 1924, pl. xvi, fig. 2; non Nicholson and Etheridge 1879.

Holotype: F. 4104. University of Queensland collection; from near Oakey Creek, Silverwood, Queensland, Couvinian.

Diagnosis: Thamnopora, in the form of thin undulating laminae which may bifurcate. Corallites small and diverging from an undulating surface. Corallite walls greatly dilated except for a narrow zone at the axis. Corallites polygonal to round or slightly elliptical at the axis, round at the periphery. Septa absent. Mural pores small and rare. Tabulae complete, rare.

Description: The corallum is in the form of thin laminae, 3 to 6 mm. thick. The laminae are mainly undulating but sometimes take a sharp turn of about a right angle. The laminae may divide dichotomously but, as far as observation of limited material indicates, only rarely. The corallites diverge outwards in both directions from the median surface of the laminae; in the centre of the laminae the corallites run parallel to the median surface, this layer consisting of usually two or three, but sometimes four corallites; these usually turn sharply at right angles so that the calices are only slightly or not at all oblique; in some parts, however, the corallites diverge at an angle as low as 60 degrees to the median surface, and the calices are then oblique. In this median portion of the laminae the corallite walls are thin or slightly dilated. The corallites expand considerably in diameter when they diverge from the axial surface and the walls become greatly dilated. In the undilated axial region the corallites are rounded rarely polygonal or oval, about 0·25 mm. in diameter; at the surface their diameter is about 0·75 mm., but the walls are about 0·2 mm. thick, leaving the lumen about 0·35 mm. in diameter. On the surface or in a tangential section the calices appear as round openings set in the dilatation of the walls. Septa are absent. Mural pores are rare and have only been observed as occasional breaks in the wall in the median portions of cross sections of laminae. Complete horizontal tabulae can occasionally be observed.

Remarks: I have had great difficulty in determining the genus to which this form should be referred. In external appearance it agrees very closely with "*Coenites expansus*" de Koninck, and only thin sections show it to be distinct from the latter. The difficulties were increased in two ways—first the loss by fire of the de Koninck's types and the fact that all topotypes of *C. expansus* that I have examined are silicified and badly preserved, and secondly the genus *Coenites* has not been redescribed from thin sections of topotypic material. Eichwald, 1829, created the genus and described two species *C. juniperinus* and *C. intertextus*. He gave a short description and a figure of *C. intertextus;* the genolectotype is *C. juniperinus* (see Bassler 1915, p. 254) topotypic material of which has never been figured. Forms identified as *C. juniperinus* from other localities have been described and figured by several authors; these agree with Eichwald's description in being lamellar and having semi-circular or triangular calices. Lecompte (1933, p. 10, 1939, p. 62) summarised

the earlier work and gives the following diagnosis: "Corallum tabulate branching, lamellae or massive, but in this last case finely zoned. Corallites conical, with very limited development, in consequence of the rapid thickening of the walls, leading to the progressive constriction of the visceral chambers and causing a precocious senility. Calices semilunar or horseshoe shaped. Tabulae few. Mural pores rare. Septa occasionally represented by three processes in the calices." In the absence of a description and figures of the genolectotype I am following Lecompte's diagnosis. It should be noted, however, that this diagnosis excludes such forms as *Coenites seriatopora* (Ed. and H.) (see Oakley 1936, p. 20). On this diagnosis *Coenites* bears a similar relationship to *Alveolites* as does *Thamnopora* to *Favosites*, except that the corallites of *Coenites* are of more restricted development than in *Thamnopora*.

Thus *Thamnopora foliata* is like *Coenites* in its growth form and like *Thamnopora* in all other characters, and I therefore propose to emend the diagnosis of *Thamnopora*, as above p. 45, to include laminar and encrusting forms.

The holotype was figured by Richards and Bryan (1924, pl. xvi, fig. 2) as *Pachypora meridionalis* the identification being made without thin sections and the crystallinity of the limestone obscuring the fact that the corallum is laminar.

Localities: Por. 73, Par. Copperfield, Clermont (F. 4037, F. 4038, 4040, 4041, 4042, 4043, Univ. of Q. collection), near Oaky Creek, Silverwood, Q. (F. 4104, Univ. of Q. collection); Limestone Siding, Silverwood, Q. (F. 4356, Univ. of Q. collection).

Genus Striatopora Hall.

Striatopora Hall 1851, p. 400.

Genotype (by monotypy): *S. flexuosa* Hall, 1851, p. 400.

Diagnosis: Favositidae with the corallites diverging from an axis or a plane at an angle which is at first acute but rapidly increases to, in some species, 90 degrees but in other species considerably less. The walls are undilated in the axial portions but much dilated towards the surface. Septa are absent in the undilated portions but occur in the dilated portions as short lamellae which may break into spines on the axial edges. Neither lamellae nor spines extend beyond the dilated zone. Tabulae and mural pores are present.

Remarks: Many species have been ascribed to this genus but few thin sections have been figured, and many species which belong elsewhere have been placed in it. The presence of ridges or of striations in the calices has been taken as an important diagnostic character but few appear to have recognised them as lamellar septa although Lindstrom suggested this (1896, p. 21). The above diagnosis is based on sections of topotypic material of the genotype and topotypic material of *S. halli* Lindstrom. The diagnostic characters have usually been taken to be first oblique much expanded calices and second striations (septal lamellae) in the calyx. These characters are present in *S. flexuosa* the expanded calices being mainly the result of the obliquity of the calices. In sections septal lamellae can be seen in the calices and also occasionally in the dilated parts of the corallites. In *S. halli* the corallites open at right angles to the surface so that the calices are not much expanded, but the corallites increase considerably

in size on diverging from the axis. The corallum is much larger than in *S. flexuosa,* as are the corallites though the calices are smaller; the septal lamellae are longer and more numerous. In both species dilatation of the walls is absent or almost so until the corallites turn towards the surface when it increases very rapidly, nearly filling the corallites.

The expanded cup-shaped nature of the calices with the dilatation and septal striae have generally been taken as the generic characters, but the first of these must be omitted if *S. halli* is to be retained in the genus. In any case it seems to me to be a character more of specific than generic value. Similar expanded calices occur in some species of *Thamnopora.* Thus the essential difference between *Thamnopora* and *Striatopora* is the presence of lamellar septa in the latter. All other characters are essentially the same. Figures of *S. flexuosa* and *S. halli* are included for comparative purposes (Pl. 1, figs. 8, 9).

In both *S. flexuosa* and *S. halli* the trabeculae are holacanthine and strong and thick; in the Clermont species the material is not well enough preserved to allow of determination.

Tripp (1933, pp. 131-2, pl. xvi, figs. 5-7, text figs. 50, 51) described and figured two varieties of *S. halli* from Groganshuvfud, Gotland, in which there is progressively less dilatation and increase in size of the calices. He missed, however, the all-important point that the septal spines have lamellar bases.

Two species from Clermont are doubtfully placed in *Striatopora.* The preservation is such that, in spite of the examination of several sections of each, it is impossible to be certain that septal lamellae are present. It seems probable however that they are present.

STRIATOPORA? HILLAE *sp. nov.

* In recognition of Dr. Dorothy Hill's excellent and extensive work on the coral faunas of Australia.

Pl. II, fig. 4.

Holotype: The specimen in the collection of the Geological Survey of Queensland H. 101 with two sections from Douglas Creek, Clermont. Upper Couvinian.

Diagnosis: Striatopora? with coralla of large diameter and with the corallite walls excessively dilated near the calices, and large, distant, uniserial mural pores.

Description: The corallum is up to 4 cm. in length and varies from 8 to 20 mm. in diameter. The coralla are embedded in matrix and branching has not been observed. The corallites are polygonal, but rounded internally by thickening in the peripheral parts, little rounded in the axial; 0·5 to 0·75 mm. in diameter at the axis, expanding rapidly towards the surface of the coralla so that they reach 1 to 1·5 mm. in diameter; they curve away from the axis slightly at first then rapidly so that the calices are only slightly oblique. The dilatation of the corallites is slight in the axial part of the corallum but increases very rapidly towards the calices so that the calices are reduced to one third or less of the diameter of the corallites. Septa are probably represented by short lamellae but no spines are present. The mural pores are large, circular, distant and in one row. The tabulae are thin and complete, about nine in a space of 5 mm.

Remarks: Whether this species should be placed in *Striatopora* or *Thamnopora* turns on the presence or absence of septal lamellae. It is unfortunate that the preservation does not allow this to be determined with certainty, but the evidence seems to me to favour their presence. It is remarkable, however, that the lamellae if present do not break into spines on the axial edges. The rapidity with which the dilatation of the corallite walls increases once the corallites have diverged from the axis is a conspicuous feature and in this the species approaches *S. halli*, with which it is also comparable in size of corallum and of corallites. It differs from *S. halli* in not having septal spines and in having one row of large mural pores instead of one or frequently two rows of small pores. I know of no other species with which it is closely comparable.

Locality: Por. 73, Par. Copperfield, Clermont. (Univ. of Q. coll. F. 3985) ; Douglas Creek, Clermont (Geol. Sur. of Q. coll. H. 101).

STRIATOPORA? PLUMOSA† sp. nov.

† *Plumosus, a, um,* feathered, alluding to the frequent plume like appearance of the corallum on natural sections.

Pl. I, fig. 5.

Holotype: The specimen F. 3987 (two sections) Univ. of Q. collection, from Por. 73, Par. Copperfield, Clermont. Upper Couvinian.

Diagnosis: *Striatopora?* with coralla of fairly large size, with the corallite walls moderately dilated towards the calices and very short lamellar septa breaking into spines on the axial edge. Mural pores are rare but large and uniserial. The tabulae are complete and fairly numerous.

Description: Coralla up to 3 cm. in length and 1 cm. in diameter have been observed though smaller than these dimensions are more common. The diameter of the corallites is 0·5 to 0·75 mm. and the walls are slightly dilated in the axial portion and moderately dilated in the peripheral portion. The crystalline and muddy nature of the matrix makes the observation of the type of septa difficult. Septal spines are undoubtedly present and numerous, and while the evidence is not conclusive, it seems almost certain that the spines have very short lamellar bases. The tabulae are complete, horizontal or concave about 15 in 5 mm.

Remarks: As with *Striatopora? hillae* there is difficulty in deciding whether this species should be placed in *Striatopora*. With the poor state of preservation it is impossible to be certain whether or not the septa have lamellar bases but the balance of evidence is that very short lamellar bases are present and it is therefore doubtfully placed in *Striatopora*. Both *S? hillae* and *S? plumosa* are larger than most species of the genus although smaller than *S. halli*. In *S.? plumosa* the corallite walls are much less dilated than usual.

Locality: Por. 73, Par. Copperfield, Clermont. University of Q. collection, F. 3987. F. 3988 (each specimen consists of a dozen or more coralla). Upper Couvinian.

Genus GEPHUROPORA Etheridge.

non *Columnopora* Nicholson 1874, 1875 (a), (b), 1879 which he later stated to be *Calapoecia* Billings.

Columnopora (*Gephuropora*) *Etheridge* 1920, pp. 2-6, pls. xiv, xv.
Columnopora Lecompte 1939, p. 95.

Genotype: (by monotypy) *G. duni*, Etheridge, 1920, p. 6, pls. xiv, xv, from the Devonian of Cavan, N.S.W.

Diagnosis: Tabulate corals in which small longitudinal tabulate tubules occur in some of the corners of the corallites and more rarely in the common wall of two corallites. The septa are spinose but probably have short lamellar bases. Mural pores are present.

Remarks: The Australian material is sufficiently well preserved to show the larger structures, such as septa, well, but insufficiently so to show definitely the microscopic structure of the skeleton. Thus the determination of the relationships of *Gephuropora* is exceedingly difficult.

Billings, 1865, proposed *Calapoecia* for three Ordovician species of Canadian corals but gave no figures. Nicholson, 1874, proposed Columnopora for certain Ordovician Canadian corals and later, 1875 (a), (b), 1879, described and figured these again, but in 1889 after an examination of some of Billings's material he agreed that they are congeneric. Rominger in 1876 (see Lang, Smith and Thomas, p. 231) distributed page proofs of his 1876 [?1877] work, proposing *Houghtonia*, genotype *H. huronica*, but in the completed work, 1876 [?1877] he noted this to be a synonym of *Columnopora* Nicholson. Etheridge, 1920, thought *Gephuropora* to be closely allied to, if not identical with, *Columnopora* Nicholson. Lecompte, 1939, described three species from the Couvinian of the Ardennes which he referred to *Columnopora* Nicholson. He does not discuss its relationship to *Calapoecia* Billings and had not apparently seen Cox's, 1936, revision of that genus. These three species are here regarded as congeneric with *Gephuropora.*

Gephuropora appears at first sight very like a massive *Favosites* but the presence of tubules in the angles and sides of the corallites at once distinguishes it. The corallites are polygonal like those of a *Favosites* and the young corallites when they appear are three or four sided, the sides rarely being slightly curved, with the concavity towards the interior of the young corallite. In longitudinal sections where a corallite wall is cut tangentially it presents an aspect unusual in the Favositidae; little work has been done on the microscopic skeletal structure of the Favositidae but from limited observations of my own, it appears that the epitheca consists of a narrow zone of fibres which diverge from the median dark line. These fibres may be continuations of the fibres of septal trabeculae or may be independant of any trabeculae. No observations have been made to show that a granular layer is present as in the epitheca of simple and possibly some compound Rugosa. When a longitudinal section is tangential to the wall these fibres appear in cross section as a multitude of minute dots giving a uniform texture, interrupted, if septal spines are present by much larger circular dots with a fibrous radial structure. Thus each septal spine appears to consist of one trabecula. In *Gephuropora* the wall, while having the uniform texture and, in parts, cross sections of septal spines, is in other parts disconnectedly streaky in a longitudinal direction as in most Rugosa. In the Rugosa the streaky appearance is due to the trabeculae of the septa being so close together (or alternately the fibres of the trabeculae so long) that the fibres of adjacent trabeculae unite forming a continuous vertical plate, the streaks in the section being the bases of these plates. In *Gephuropora* there are two possible explanations. First the individual trabeculae forming the septal spines may assume a vertical or almost vertical direction on meeting the wall and continue downwards in the wall for some distance; or second the septa may consist of a very narrow lamellar portion in which inclined trabeculae are in contact, with either some of the trabeculae projecting beyond the

lamellar portion forming spines or else on the axial edges of the lamellae the radiating fibres of the trabeculae are shorter than those in the lamellar portions so that spines are formed. In the first case there would be discontinuous lamellar bases to the septa, each such lamellar base consisting of one, more or less vertical but probably compound trabecula; in the second the longitudinal streaks would consist of oblique sections of trabeculae in contact.

The longitudinal streaks are so close together that it seems that the trabeculae in the lamellar bases must be compound. Better preserved material is required before more definite statements can be made on this subject. Lecompte, 1939, did not recognise lamellar septa in his species. Nicholson, 1874, Lambe, 1899, and Cox, 1936, all describe the septa of *Calapoecia* as being short lamellae, spinose on the inner edge. The only other Favositidae in which I have observed this wall structure is in those with lamellar septa as *Angopora* Jones, 1936, *Striatopora* Hall and in *Favosites goldfussi* d'Orb. from the Eifel. The wall of Silurian species of *Favosites* never in my experience shows this structure. Whether or not it is general in Devonian species I am unable to say, as of the Devonian material at my disposal only that from the Eifel is well enough preserved to show the structure of the wall. The septal spines of *Gephuropora* are conical in shape with a broad base and sharply pointed, sometimes directed slightly upward. This description applies equally to the spines in *Calapoecia* but in the latter the septa are "typically twenty" (Cox 1926, diagnosis p. 2). Cox also says, p. 2: "The writer is able to state that in all the specimens of this genus he has examined the number of septa is constantly twenty" (this is the case in the one specimen of which I have thin sections) whereas in *Gephuropora* it is not possible to state how many septa there are in a cycle because they are very sporadically distributed as in *Favosites*. Thus parts of some sections, both transverse and longitudinal, of *Gephuropora* as is also the case in *Favosites* (except those with long and abundant septa) show no septa at all. Rarely in *Gephuropora* lamellar septa are suggested in transverse section by the wall appearing like a string of beads as in *Angopora*. In *Calapoecia*, as Cox states, the lamellar bases of the septa can be seen in sections and as ridges in weathered specimens.

Cox, 1936, examined a large number of specimens of *Calapoecia* including Billings's and Nicholson's material and he says there is "no true wall and the corallites are bounded by an open lattice work of septal elements, recognisable in either longitudinal or transverse sections by the radiation of fibres which constitute them" (p. 8), and "consequently the corallite boundary must be considered as a cribriform stereozone" (p. 21). In the Rugosa a tangential section of the epitheca shows, between the trabeculae which are the bases of the septa, innumerable cross sections of the minute fibres normal either to the median dark line or the dissepiments; this is the case also in *Favosites* (except possibly *F. goldfussi*), but in *Calapoecia* the fibres of adjacent trabeculae do not meet except at regular intervals where the septal lamella give rise to spines with so broad a base that they usually unite laterally forming cross bars. The spaces bounded by these cross bars and the septal lamellae are the "mural pores." Thus the "mural pores" in *Calapoecia* are spaces between the septal elements; in *Favosites* they are holes piercing the wall fibres. The material of *Gephuropora* and *F. goldfussi* is not good enough to determine if there are fibres between the trabeculae (if such they be) or not, but in any case the mural pores pierce the

trabeculae and any fibres which exist between them. Further in *Calapoecia* the "mural pores" pierce a median stereozone (see Jones and Hill 1940, footnote p. 194), whereas in *Favosites* and *Gephuropora* the mural pores pierce the epitheca. Thus the "mural pores" of *Calapoecia* are not a structure analogous to the mural pores of *Gephuropora* and *Favosites*.

Cox found a continuous gradation between *Calapoecia canadensis* with the corallites in contact and no "coenenchyme" to *C. anticostiensis* with circular corallites, "costae" and a "coenenchyme" of tabulae. The question arises whether the tubules of *Gephuropora* represent the "coenenchyme" of *Calapoecia*. At first sight this appears probable especially as two af Nicholson's figures (1879, pl. vii, figs. 2a, 2b) are very like transverse sections of *Gephuropora*, except that they show tubules not only piercing the median dark line of the walls but also "accompanied by smaller rounded and definite vacuities (Pl. vii, fig. 2b) which are situated in the substance of the walls themselves." This has not been observed in any transverse sections of *Gephuropora* (although the tubules are not invariably right in the centre of the wall), but in one instance in a longitudinal section a tubule after following the median line of the wall for some distance diverged from it for a short distance. In *Gephuropora* the tubules have tabulae at distant and irregular intervals. Etheridge says of the tubules (p. 4) "the walls of these circular bodies are identical in structure with the primordial walls of the corallites, and also have a stereoplasmic thickening." This is strongly supported though not definitely proved by my own observations. There is also some evidence of mural pores piercing the walls of tubules. It appears then almost certain that the tubules of *Gephuropora* were occupied by coral tissue.

Cox, 1936, examined Nicholson's specimens of *Columnopora* and agreed with Nicholson and Lambe that it is identical with *Calapoecia*, placing *Columnopora cribriformis* Nicholson as a synonym of *Calapoecia canadensis*, i.e. *Calapoecia* with no "coenenchyme." He says the "intramural vacuities" (i.e. the "intramural canals" of Nicholson resembling according to Nicholson's figures, the tubules of *Gephuropora*) in Nicholson's material and his own material of *C. canadensis* do not always occur in the wall but usually near it; they are in longitudinal section circular to inflated vermiform, and *show no structure*. He thinks they may be due to some boring animal. If Cox's interpretation is correct then the tubules of *Gephuropora* cannot be the same as the "intramural vacuities" of *Calapoecia canadensis* but they may still be a much reduced "coenenchyme" like that in *C. anticostiensis*, but the evidence is that the wall of *Gephuropora* has a structure like that of *Angopora* or a "*Favosites*" with lamellar bases to the septal spines and must therefore be regarded as an epitheca not as a cribriform stereozone such as that of *Calapoecia*. *Gephuropora* must therefore be regarded as distinct from *Calapoecia*. The tubules of the three species described by Lecompte have tabulae so that they may be regarded as congeneric with *Gephuropora*.

GEPHUROPORA DUNI Etheridge.

Pl. II, fig. 6; pl. III, figs. 1-4.

Gephuropora duni R. Etheridge jun. 1920 pp. 2-6, pls. xiv, xv.

Holotype: Etheridge's material was probably in the Mining Museum, Sydney, but cannot be traced. The horizon of his material is uncertain but the species is interpreted upon specimens some of which are probably topotypes.

Diagnosis: Gephuropora in which the corallites are large, septal spines irregularly developed and tubules very irregularly distributed and variable in size.

Description: The external form of the corallum is unknown as only fragments have been found, but it was massive and probably the corallites radiated from a point. The corallites are usually of two orders of size, the larger being about 2 mm. in diameter and the smaller 1·5 mm. The corallites are polygonal but may be rounded by thickening, the walls being moderately thin to thick. The wall wherever cut tangentially has a streaky appearance suggesting trabeculae and lamellar bases to the septa. The septal spines are very variable in development, some parts of a corallum being almost free while other parts show many spines. In form they are usually short blunt spines with a broad base and occur at the same level in contiguous corallites; but longer sharp spines occur in parts and they may alternate in contiguous corallites. The mural pores are large and numerous, typically in two rows which may, but usually do not, alternate, sometimes in one or three rows. The tabulae are usually regular, rarely incomplete, horizontal, inclined or flexuous, usually about 12 in 5 mm., but there may be as many as 22. The tubules vary in number in different parts of the same corallum and in different coralla. They occur more frequently in the angles but also in the sides. They are circular and in size vary from 0·2 mm. to 0·5 mm. Tabulae are rarely and irregularily developed in the tubules.

Remarks: The above description is based on specimens from Clermont, Cavan and Buchan. There is considerable variation from specimen to specimen but so much variation occurs in individual specimens that I consider they are best treated as one variable species. The Clermont specimens are moderately thin walled, while most of the Cavan specimens are thick walled but one is quite thin walled. The Buchan specimen is thin in one part but thick in another. The variation in the development of septa is similar. The Buchan specimen was previously recorded by the writer, 1937, p. 98, as *Favosites multitabulata* Jones. This error was due to the fact that no tubules appear in the transverse part of the section while the few which show in one part only of the longitudinal were mistaken for cavities caused by some boring animal. *F. multitabulata* is not known to exist at Buchan.

Of the three species described by Lecompte from the Bassin du Dinant, *G. duni* is closest to "*Columnopora*" *maillieuxi* but differs in having smaller corallites, tubules in the walls of the corallites as well as the angles, more septa, more mural pores and more numerous tabulae.

Localities: Por. 73, Par. Copperfield, Clermont, Queensland, F. 3959-62 (Univ. of Q. collection). Other specimens studied are from the Limestone near the Yass end of the Taemas Bridge, Cavan, N.S.W., the "Currajong" limestone 0·7 miles from the Taemas Bridge towards Wee Jasper, the "Bluff limestone 0·5 miles from the Taemas Bridge towards Wee Jasper, Cavan, N.S.W. (Lower Middle Devonian). Lecompte's species came from the Lower and Upper Couvinian, "*Columnopora*" *maillieuxi* being from the Upper Couvinian.

Genus SCOLIOPORA Lang, Smith and Thomas.

Alveolites Milne-Edwards and Haime 1851, p. 258, pars.
Plagiopora Gurich 1896, p. 143.
Plagiopora Lecompte 1939, p. 139.
Scoliopora Lang, Smith and Thomas 1940, pp. 101, 118.

Genotype: Alveolites denticulatus Milne-Edwards and Haime, 1851, p. 258, pl. xvi, fig. 4. Devonian, Bensberg, Westphalia, Germany.

Diagnosis (as given by Lecompte): Tabulate coral, branching or lamellar, with calices furnished with one to three spiniform projections generally elongated transversely and opening perpendicularly to the surface. Walls thickened distally. Mural pores numerous. Tabulae distant in the axis of the colonies, crowded outside them. Increase by fission.

Remarks: This genus was founded by Gurich, 1896, for two species —*Alveolites denticulatus* Ed. and H. 1851, p. 258, and *Plagiopora dziwkiensis* n. sp. Gurich gave a short diagnosis. The genus is apparently rare and until Lecompte, 1939, no author has described the genus in detail though Gurich, 1909, Lebedew, 1902, Cowper Reed, 1908 and 1922, Sobolew, 1909, and Lecompte, 1939, recorded species.

Lecompte, 1939, describes the genus, three species and a variety, in detail with figures of thin sections. He was unable to find the holotype of *A. denticulatus* Ed. and H. in the Verneuil collection nor were thin sections of topotypes existing in that collection available. Nevertheless there appears little doubt that Lecompte's material belongs to this genus. In his diagnosis Lecompte indicates that the thickening of the walls increases distally but shows in his description of the species that this character varies, thus in *S. kaisini* he says (p. 145) "Parois peu épaisses, a renflenment distal nul ou peu accentué."

Lang, Smith and Thomas, 1940, point out that *Plagiopora* is preoccupied for a Tertiary Polyzoan and propose the name *Scoliopora* in its place.

SCOLIOPORA FLEXA* sp. nov.

* flexus—winding.

Pl. III, fig. 5.

Holotype: Specimen in the collection of the Geological Survey of Queensland, 66, from the Lower Middle Devonian of Douglas Creek, Clermont.

Diagnosis: Lamellar, encrusting *Scoliopora*, with the corallite walls uniformly thickened throughout their length or with a slight increase of thickening distally. Calices circular or meandrine rarely kidney shaped. Mural pores rare, circular, in one row. Tabulae thin, complete predominating, rarely incomplete and inosculating.

Description: The external form is difficult to discern as the corallum is embedded in limestone. It is probably lamellar and encrusting with the corallites frequently changing their direction of growth so that one surface may present both transverse and longitudinal sections of corallites. The walls of the corallites are usually thickened uniformly throughout their length, but rarely there is an increase in thickening distally. The thickness ranges from 0·12 mm. to 0·75 mm. The calices open perpendicularly to the surface, are circular, oval, meandrine or occasionally kidney shaped. The diameter of the circular calices ranges from 0·25 mm. to 0·4 mm., while the meandrine ones may be as long as 2·5 mm. and as wide as 1 mm. The dilatation of the walls frequently reduces the width of the lumen to half or less than half the width of the corallites. Septa are absent. A thick spiniform projection occasionally present. The mural pores appear in only one place in three sections where they are small circular and apparently in one row. The tabulae are thin and nearly always complete though odd ones are incomplete and inosculating.

Remarks: Only one specimen of this species has been found at Clermont. There is some slight doubt in my mind as to whether it should be referred to *Scoliopora*. *Scoliopora* as interpreted and illustrated by Lecompte has calices mostly shaped like those of *Coenites,* whereas in *flexa* the calices are mostly circular or meandrine. Further the species of *Scoliopora* described by Lecompte have one to three spines well developed but in *flexa* it is only rarely that a spine is seen. Mural pores are much more numerous in the species described by Lecompte.

Lecompte's species are from the Givetian and Frasnian.

Locality: Douglas Creek, Clermont (Geol. Surv. Qld. 66).

Family SYRINGOPORIDAE.

Genus SYRINGOPORA Goldfuss.

Syringopora Goldfuss, 1826, p. 75.

Genotype: *S. ramulosa* Goldfuss, Carboniferous, Olne, near Limber, Germany.

SYRINGOPORA cf. SPELAEANUS Etheridge.

Pl. III, fig. 6.

Syringopora spelaeanus Etheridge, 1902, p. 258. Pls. xxxvii, fig. 2, pl. xxxviii.

Remarks: One poorly preserved specimen which is probably *S. spelaeanus* is in the Geological Survey of Queensland collection (66). Etheridge described, and figured externals of this species from Cave Flat, Murrumbidgee R., and I have examined thin sections of a specimen collected by Miss Hill from the same horizon at Wee Jasper which agree well with Etheridge's description. The Clermont specimen is highly crystalline but the size, appearance and what little can be seen of internal structure agree with the Murrumbidgee material.

The specimen from Wee Jasper and Etheridge's description of the Cave Flat specimens suggest a relationship of *S. spelaeanus* to *S. eifeliensis* Schluter, 1889, p. 167, pl. xv, figs. 1-5. The size is similar but while *S. spelaeanus* has very short lamellar septa broken into spines on the axial edge, *S. eifeliensis,* judging by Schluter's description and figure (Pl. xv, fig 5) has spines alternating with short lamellae, so that it is possibly a Rugose coral, minor septa being unknown in the Tabulata. (Etheridge did not mention the lamellar septa of *S. spelaeanus* apparently not having examined thin sections. Etheridge compares the species with *S. abdita* de Verneuil (Edwards and Haime 1851. p. 295, pl. 15, fig. 4) but points out that the latter has many fewer septa. Lecompte (1939, p. 168) records a slightly smaller form as *S. eifeliensis* Schluter from the Upper Givetian but says it has no septa, being thus distinguished from *S. abdita* de Verneuil.

Locality: Douglas Creek, Clermont, por. 73, Par. Copperfield, Geol. Surv. Q. 66.

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R.S.—G.

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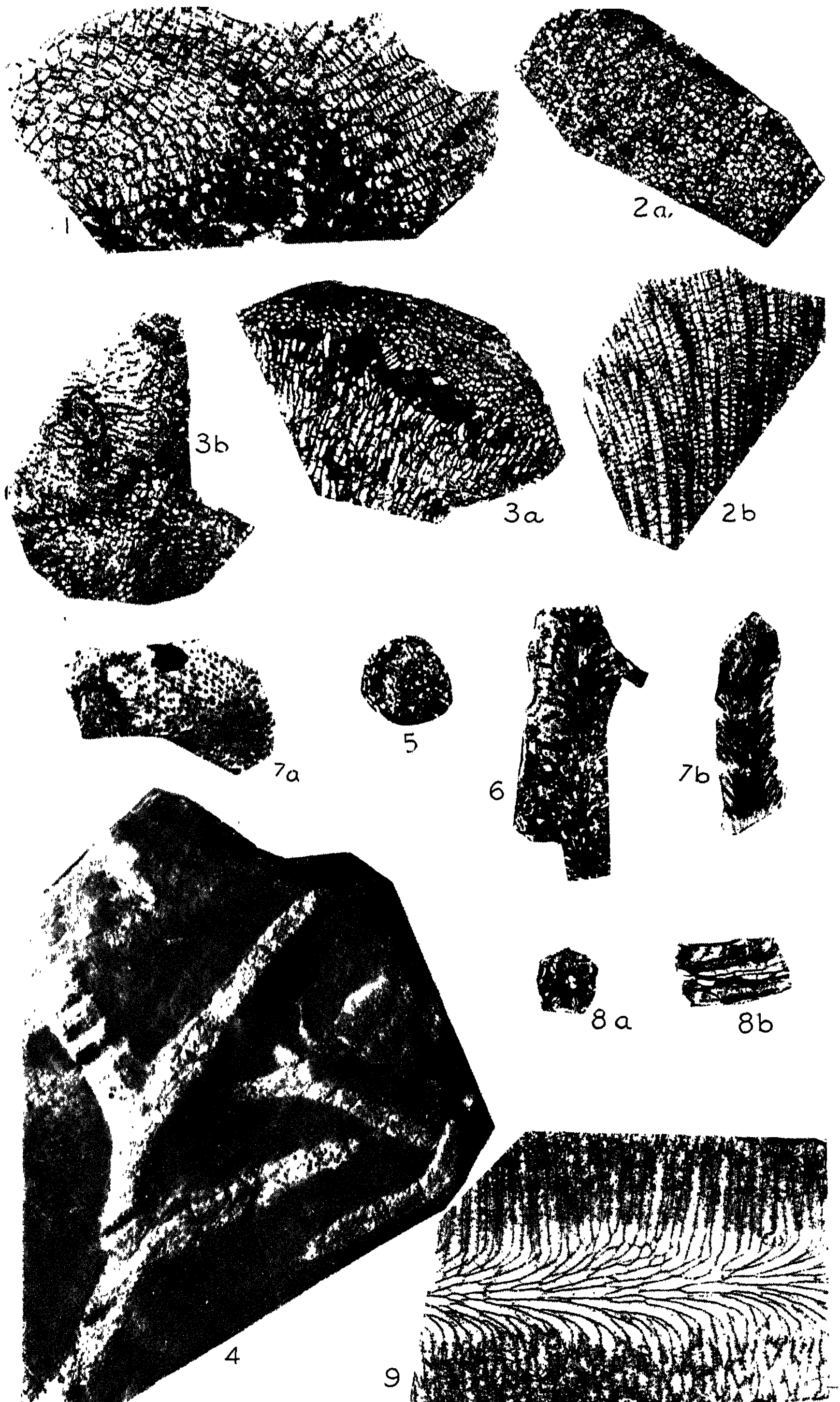
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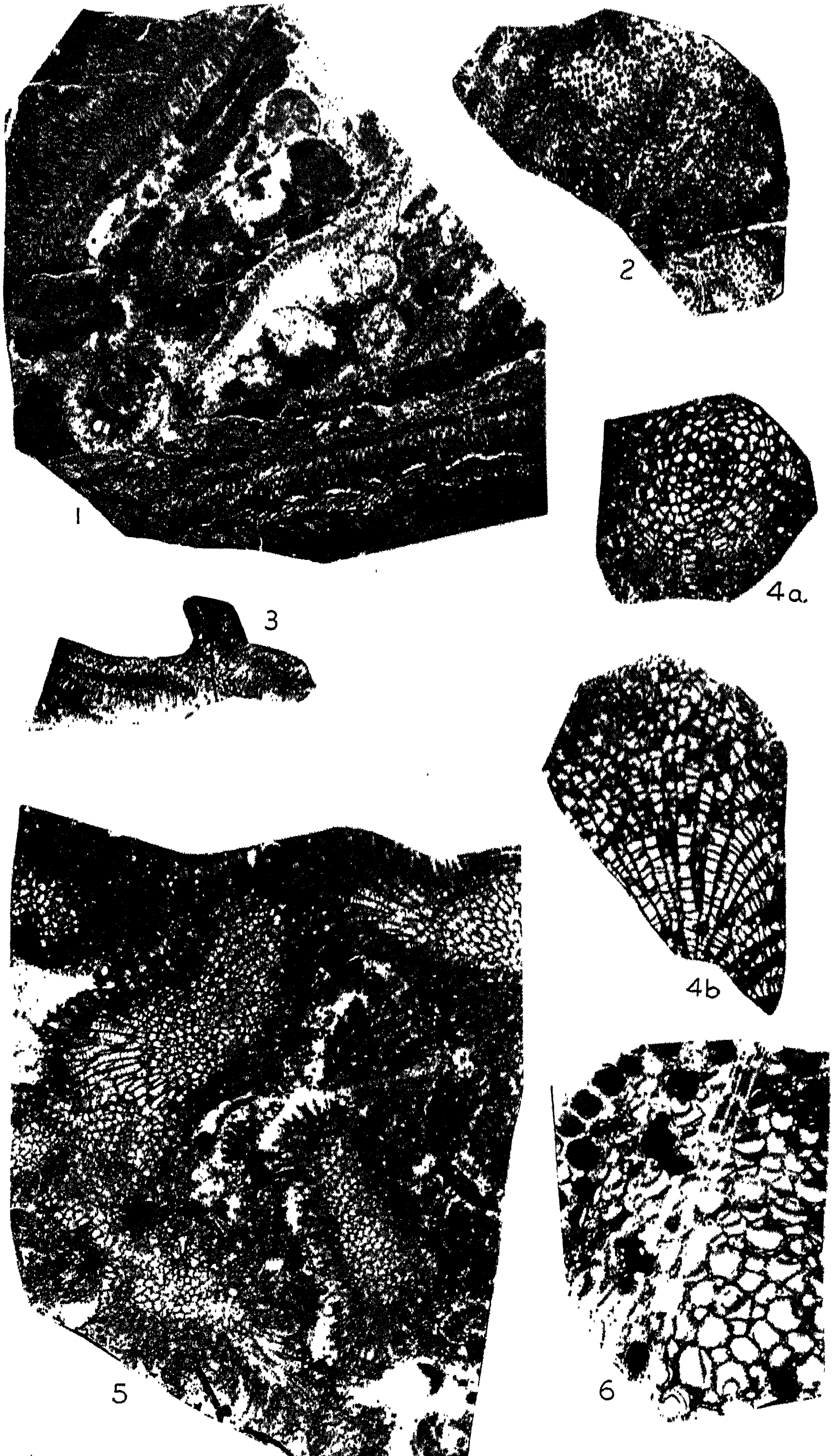
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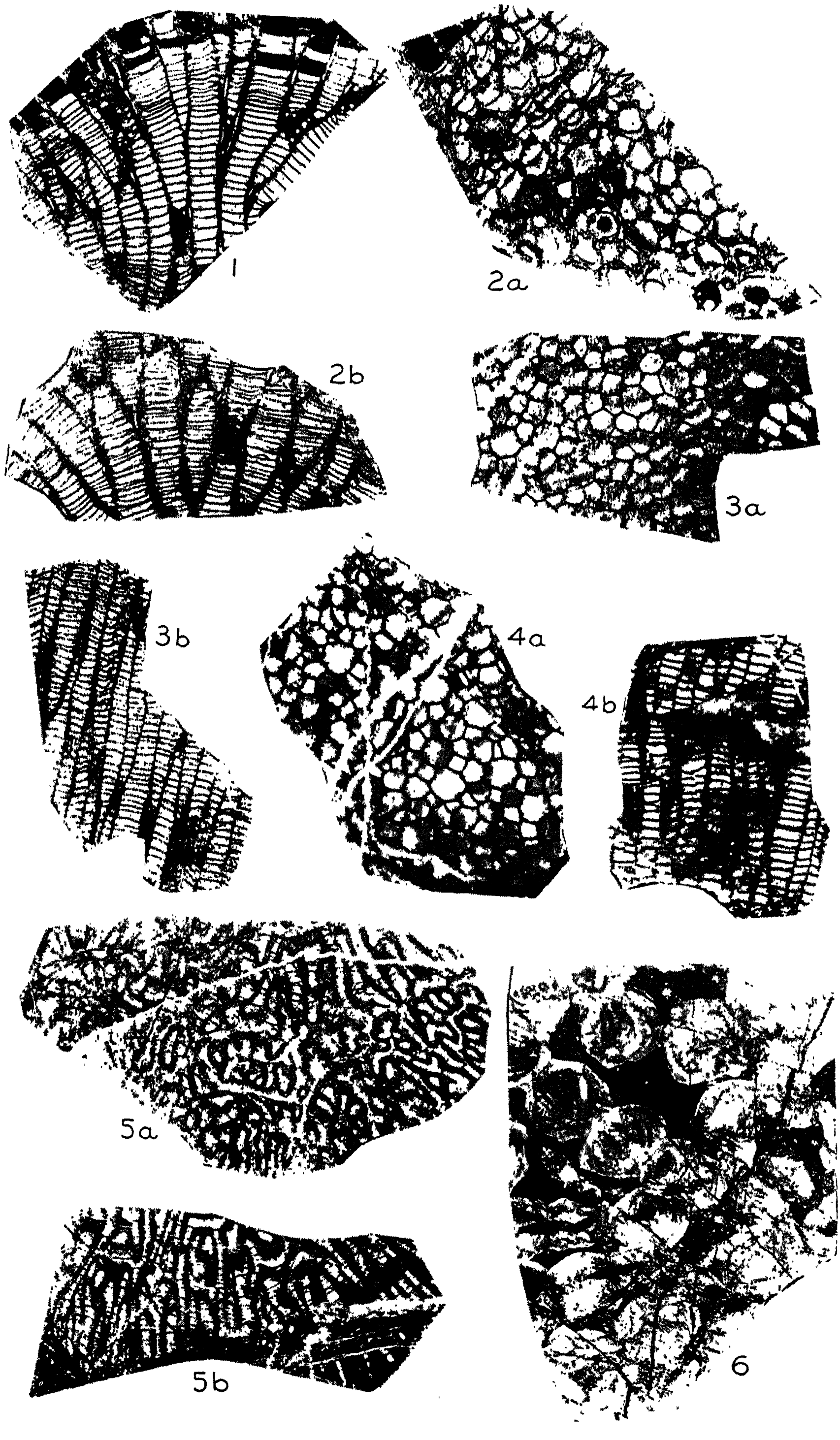
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FRAGMENTA LEPIDOPTEROLOGICA.

By A. JEFFERIS TURNER, M.D., F.R.E.S.

(Tabled before the Royal Society of Queensland 25th November, 1940.)

Fam. BOMBYCIDAE.

PANACELA NYCTOPA Turn.

In describing this species I proposed for it the genus *Mallodeta* based on veins 3 and 4 arising separately in both wings. Examination of a series of one male and eight females shows that in two of the latter these veins are long-stalked on both sides as in *Panacela* Wlk. The species must therefore be referred to that genus, with which it corresponds otherwise, and the former genus must be dropped.

Fam. NOTODONTIDAE.

Subfam. Cnethocampinae.

EPICOMA BARNARDI Luc.

♀. 44 mm. Head and thorax ochreous. Forewings pale ochreous, basal half sprinkled with dark fuscous; a dark fuscous discal mark at three-fifths, confluent with a broad sinuate dark fuscous line from three-fourths costa to three-fifths dorsum; a terminal dark fuscous fascia containing a series of pale ochreous marginal spots; cilia dark fuscous with a series of pale ochreous sub-basal dots. Hindwings dark fuscous with a series of pale ochreous oval terminal spots; cilia as forewings, but pale ochreous dots less developed.

This description is taken from a specimen in the Queensland Museum and should replace that given in Proc. Lin. Soc. N.S.W. 1922, p. 368, which was drawn from females of *E. asbolina* mistakenly referred to this species.

Fam. LARENTIADAE.

POECILASTHENA FRAGILIS n.sp.

fragilis, frail.

♂ ♀. 25-30 mm. Head pale bluish-green; fillet white; face reddish-orange. Palpi minute; white. Antennae pale grey, towards base white, in male minutely ciliated. Thorax pale bluish-green. Abdomen white, sometimes tinged with pale bluish-green on dorsum. Legs white; anterior pair grey. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique; pale bluish-green with numerous fine transverse rippled white lines, more distinct towards termen; a darker median bluish-green discal dot; costal edge whitish; cilia pale bluish-green, bases white. Hindwings with termen slightly rounded; as forewings but without discal dot. The coloration is fugitive, worn examples being almost white; for which reason I have chosen a female as the type. It has been confused with *P. oceanias*, but may be distinguished by the discal dot and the disproportionately larger forewings, both these and the hindwings being without any yellowish or ochreous tinge.

New South Wales: Ebor in December. Victoria: Sale. Tasmania: Burnie; Zeehan; Rosebery; Cradle Mt.; and Weldborough in January; seven specimens.

POECILASTHENA OCEANIAS Meyr.

Proc. Lin. Soc. N.S.W. 1890, p. 816.

This was described from a single female taken at Albany. Seven female examples from Denmark (W. B. Barnard) correspond closely, but a male I took at Collie has a broader ochreous costal streak, the vertex of head brownish, and the antennae pale grey.

POECILASTHENA PISICOLOR n.sp.

pisicolor. pea-green.

♂. 22 mm. ♀. 25-28 mm. Head pale yellowish-green; fillet white; face reddish-orange. Palpi brown-whitish. Antennae whitish; ciliations in male one-third. Thorax pale yellowish-green. Abdomen whitish, dorsum greenish-tinged. Legs whitish; anterior pair pale brownish. Forewings triangular, costa slightly arched, apex pointed, termen nearly straight, oblique; pale yellowish-green with very faint rippled transverse whitish lines; costal edge whitish; cilia whitish, bases pale yellowish. Hindwings with termen strongly rounded; colour and cilia as forewings. Differs from *P. oceanias* in the yellowish-green colour of the wings and the more pronounced yellow colour of the cilia.

West Australia: Albany and Busselton in February; Denmark in March and April; seven specimens. Type in Queensland Museum.

POECILASTHENA SCOLIOTA Meyr.

The peculiar rhombiform hindwings are confined to the male, in the female they are normally rounded.

West Australia: Busselton, Albany. Denmark.

Gen. AEPYLOPHA nov.

αἰπυλοφος, high-crested.

Tongue present. Palpi long, porrect. Thorax with a high posterior crest. Tibiae with inner spurs twice as long as outer; posterior tibiae with two pairs of spurs. Forewings with areole single; 7 from areole connate with 8, 9, 10, which are stalked, 11 running into 12. Hindwings with 3 and 4 connate, 5 from middle of cell, 6 and 7 stalked, 12 anastomosing with cell to four-fifths. A derivative of *Chloroclystis*.

AEPYLOPHA THALASSIA n.sp.

θαλασσιος, sea-blue.

♀. 26 mm. Head green; collar pale ochreous-grey. Palpi two and a half; second joint long, green; terminal joint very short, ochreous-grey. Antennae grey. Thorax blue-green, crest green. Abdomen pale grey. Legs whitish; anterior pair fuscous with whitish rings. Forewings triangular, costa slightly arched, apex obtuse, termen rounded, oblique; blue-green with dark fuscous markings; a small triangular basal patch of darker blue-green partly outlined with dark fuscous; a large triangular spot on costa before middle, giving off two fine parallel dentate whitish lines to one-third dorsum; subapical area suffused with white; a fine dentate whitish subterminal line. preceded by twin dots on costa and above middle; a tornal dot; cilia green-whitish with fuscous bars. Hindwings with termen strongly rounded; colour and cilia as forewings; slender fuscous antemedian and postmedian lines, the latter partly edged posteriorly with white, and with a strong median projection, traces of an interrupted terminal line towards apex and more distinctly near tornus.

North Queensland: Lake Barrine (Atherton Tableland) in February; one specimen received from Mr. E. J. Dumigan.

GYMNOSCELIS PERPUSILLA n.sp.

perpusillus, very small.

♂ ♀. 12-14 mm. Head ochreous-whitish. Palpi one and a quarter; fuscous. Antennae grey. Thorax and abdomen ochreous-fuscous sprinkled with fuscous. Legs whitish. Forewings elongate. costa slightly arched, apex rounded, termen very obliquely rounded; 11 running into 12; ochreous-whitish with markings and slight irroration fuscous; costal dots at base, two-fifths, and three-fifths; a very slender outwardly curved sub-basal transverse line; an interrupted line from second costal dot to one-third dorsum; another from five-sixths costa to three-fourths dorsum; ill-defined fuscous suffusions at apex, on mid-termen, and on tornus; a terminal line interrupted on veins; cilia ochreous-whitish with obscure fuscous bars. Hindwings with termen excavated above and prominent below middle; as forewings but without sub-basal line; postmedian line flattened and slightly indented in middle.

Even smaller than *G. minima* and *G. acidna*, forewings narrower with termen more oblique, and markings much more slender.

North Queensland: Cairns in June. Queensland: Noosa in May; two specimens.

GYMNOSCELIS ISCHNOPHYLLA n.sp.

ισχνοφυλλος, narrow-winged.

♂. 24 mm. Head grey; face fuscous. Palpi one and a quarter; fuscous. Antennae grey. Thorax grey anteriorly; a transverse line including tegulae whitish; posteriorly fuscous. Legs fuscous; posterior pair ochreous-whitish. Forewings narrow, elongate, costa straight to near apex, apex round-pointed, termen very oblique; 11 anastomosing with 12; whitish largely suffused with fuscous and grey; markings dark fuscous; a short dentate transverse sub-basal line joining an oblique streak from base of dorsum towards but not reaching a spot on costa at one-third; beneath and beyond this is a similar and nearly confluent spot, from which runs a fine sinuous line just beneath and parallel with the basal streak; a broad streak from before two-thirds costa towards mid-termen, acutely angled in mid-disc and continued as a fine wavy line to before tornus; closely following is a pale slender parallel line and a second line broader and dentate in costal half; a broad median streak from beyond this to midtermen, traversed by a whitish dentate subterminal line; interrupted on veins; cilia grey, towards apex fuscous, with slender whitish bars. Hindwings elongate, termen strongly rounded; as forewings but without sub-basal line; antemedian line slender, curved, interrupted before dorsum; postmedian broader and darker with strong prominence above middle; a whitish dentate subterminal line; broadly edged with fuscous anteriorly.

Similar in wing-shape to *G. tanaoptila*, but with very different markings.

North Queensland: Lake Barrine (Atherton Tableland) in May; one specimen.

GYMNOSCELIS SUBRUFATA Warr.

Novit. Zool. 1898, p. 24.

This species, which should be easily recognised by the reddish underside of both wings, is variable. I examined Warren's type which

came from Duaringa, at Tring, and have since captured two examples both from Brisbane. The first is a male taken at rest on a wooden gate on February 4th, 1908, the second a female taken in my residence on July 11th, 1940.

The forewings are whitish with diffused rippled transverse lines grey more or less tinged in parts with reddish and green; the basal patch is small and outlined with fuscous; there is a transverse fascia at one-third, pale reddish defined by fuscous lines in the male, but with anterior margin undefined in the female and posterior line broadly suffused; postmedian line from two-thirds costa obliquely outwards, straight but slightly rippled to about middle, there sharply angled and dentate to before tornus. Hindwings with sub-basal area except towards dorsum suffused with fuscous and pale reddish and edged by a fuscous line strongly projecting below middle.

CHLOROCLYSTIS DELOSTICHA n.sp.

δηλοστιχος, with distinct lines.

♀. 22 mm. Head, thorax, and abdomen grey-whitish with a few dark fuscous scales. Palpi 1; dark fuscous, apex and a median band whitish. Antennae grey. Legs fuscous with whitish rings; posterior pair mostly whitish. Forewings triangular, costa gently arched, apex rounded, termen obliquely rounded; whitish-grey with obscure transverse grey lines and dark fuscous markings; costal dots at one-sixth and one-third; two median dots, each obliquely anterior to one of these; two faint grey parallel transverse lines before middle; a very distinct postmedian line from two-thirds costa, nearly straight but slightly waved and slightly outwardly oblique to mid-disc, there angled inwards to three-fourths dorsum; a very slender sharply dentate subterminal white line preceded by dark fuscous beneath costa, opposite mid-termen, and above dorsum; a broad pale grey interrupted subterminal line; an interrupted dark fuscous terminal line; cilia pale grey, apices whitish. Hindwings with termen strongly rounded; as forewings, postmedian line with a projection beneath middle.

Nearest *C. nigrilineata*, but larger and without any ochreous tinge; antemedian line of forewings indistinct, but postmedian dark and well defined, not indented.

Queensland: Brisbane in June and July; two specimens.

TEPHROCLYSTIA TORNOLOPHA n.sp.

τορνολοφος, with tornal crest.

♂. 16 mm. Head and thorax brownish-grey. Palpi 1; brownish. Antennae grey. Abdomen ochreous-grey with a fuscous transverse bar at one-fourth. Legs ochreous-grey-whitish. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen slightly rounded, oblique; ochreous-whitish with fuscous irroration and markings; some costal strigulae; a pale sinuate subterminal fascia edged with fuscous, its anterior edge finely serrated; an obscure pale dentate submarginal line, preceded and followed by suffused fuscous lines; cilia grey with ochreous whitish bars. Hindwings with termen gently rounded; as forewings but markings ill defined except towards dorsum. Underside of hindwings in male with a large and dense subdorsal tuft of long hairs, fuscous in centre, ochreous-whitish on margin.

The type is not in very good condition, but the male should be easily recognised by the tufted hindwings.

North Queensland: Dunk Island in May; one specimen.

MICRODES DECORA n.sp.

decorus, comely.

♂. 20 mm. Head and thorax fuscous. Palpi 4; fuscous. Antennae grey. Abdomen whitish densely suffused with fuscous on dorsum. Legs grey-whitish; anterior pair fuscous with whitish rings. Forewings triangular, costa slightly arched, apex rounded, termen rounded, oblique; fuscous with some whitish scales, disc except towards costa and termen suffused with ferruginous; an ill-defined whitish line angled outwards in middle from one-third costa to one-fourth dorsum, edged posteriorly by a dark line; an obscure dark transverse median line; a fine double whitish line from two-thirds costa to before tornus, slightly outwardly curved, edged anteriorly by fuscous and posteriorly by ferruginous suffusion; a well marked fine dentate whitish subterminal line, indented beneath costa; cilia whitish with obscure fuscous bars. Hindwings with termen strongly rounded; grey; an outwardly curved double whitish transverse line at two-thirds; a finely dentate whitish submarginal line; cilia grey with whitish bars.

South Australia: Kingscote (Kangaroo Island) in May; one specimen received from Mr. F. M. Angel.

MICRODES PHRICOCROSSA Turn.

Proc. Lin. Soc. Tas. 1939, p. 67.

Owing to a confusion of specimens the description was inaccurate. It should have been based exclusively on a single worn female example in Coll. Goldfinch expanding 26 mm. (not 36 mm.). A redescription appears however to be unnecessary, for I am now of opinion, that the type is not distinct from *M. leptobrya* Turn. described before it on the same page.

EUPHYIA PERSIMILIS Turn.

New South Wales: Mt. Kosciusko, 5,000 feet. Victoria: Mt. St. Bernard, 5,000 feet; Mt. Buffalo. 4.000 feet. Tasmania: Cradle Mt., 2.000 feet. The last locality has not been previously recorded.

EUPHYIA CONIFASCIATA Butl.

Examples of this species from Tasmania, where it is common, are usually readily distinguished from those from Eastern Australia. They are on the average smaller, the yellow tinge of the hindwings is paler, and the ground-colour of the forewings is fuscous without brownish tinge. Those who wish to give this race a name may call it *tasmaniensis*. I myself do not consider it worthy of a varietal name, for examples occur, which cannot be referred positively to either island or mainland except by inspection of the locality label.

Mr. W. B. Barnard captured four examples of a West Australian race at Denmark in March. These are even more distinct from both the preceding races in the absence of yellow or ochreous tinge in the hindwings, the forewings being fuscous and white. For these the name *occidentalis* would be appropriate.

EUPHYIA TRISSOPHRICA Turn.

Proc. Roy. Soc. Vic. 1903, p. 259.

E. leptophrica Turn. (Trans. Roy. Soc S.A., 1922, p 250) is a synonym.

New South Wales: Ebor; Barrington Tops; Mt. Kosciusko. Tasmania: Mt. Wellington; Bothwell; Cradle Mt., 2,000 feet.

EUPHYIA PTOCHOPIS Turn.

Proc. Lin. Soc. N.S.W. 1906, p. 702.

E. trissocyma Turn. (Trans Roy. Soc. S.A. 1922, p. 252) is a synonym.

New South Wales: Jervis Bay; Moruya. Victoria: Melbourne; Beaconsfield. Tasmania: Hobart; St. Helens.

EUPHYIA ACTINIPHA Low.

Trans. Roy Soc. S.A. 1902, p. 248.

Mr. Geo. Lyell has sent me a specimen from Birchip, which had been identified as this species. We agree that it is a worn example of *E. epicteta* Turn. (Proc. Lin. Soc. N.S.W. 1907, p. 633). Lower's type came from Broken Hill. A careful study of his description leaves little doubt that it also applies to an example of the same species.

XANTHORHOE CROCOTA Turn.

Proc. Roy. Soc. Vic. 1903, p. 261.

Through the courtesy of Mr. Geo. Lyell I have been able to re-examine the type of this species, which I described as a *Hydriomena crocota.* Its affinities appear to be with Xanthorhoe, and the antennae may be described as very shortly pectinate (1) rather than dentate. With this I received other examples showing that the species in variable in colour. The female in poor condition from Mt. Wellington, that was doubtfully referred to this species, is that of another species probably undescribed. *X. bituminca* Turn. (Proc. Roy. Soc. Tas.) is undoubtedly the same as *X. crocota.* Of the two examples I had before me in describing this, one was a normal example, but the type a dark aberration. Since then I have taken a normal male at the same locality.

Fam. STERRHIDAE.

EOIS IODESMA Meyr.

Trans. Ent. Soc. Lond. 1897, p. 376.

I believe *E. perdulcis* Turn. (Trans. Roy. Soc. S.A.. 1926, p. 124) is a synonym.

EOIS DELOSTICTA Turn.

Trans. Roy Soc. S.A. 1922, p. 264.

This was described from a single female example. I have found three more, including one male. in the Barnard Collection, which is now in the Queensland Museum. The male has the dark fuscous dots on the body and wings more strongly developed, and two interrupted dentate pale fuscous subterminal lines on the forewings. Posterior legs in male long, slender, smooth, without spurs, tarsi as long as tibiae.

North Queensland: Cape York; Cairns. Queensland: Tweed Heads; Toowoomba.

EOIS LUCIDA n.sp.

lucidus, shining white.

♂. 14 mm. ♀. 17 mm. Head fuscous; fillet whitish. Palpi pale fuscous. Antennae whitish, towards apex grey; ciliations in male 1. Thorax and abdomen white. Legs whitish. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen almost straight, oblique; shining white; five very pale grey rippled lines at one-third, middle, two-thirds, subterminal, and submarginal; a

terminal series of black dots; an occasional irregular black scale may be detected elsewhere, but no discal dot; cilia white. Hindwings with termen rounded; as forewings.

Not unlike *E. fucosa* Warr, but differs in the absence of any ochreous tinge, and by the marginal dots of the wings. Also in that species the male antennae are thicker with longer cilia (almost 2) arranged in tufts.

Queensland: Noosa in April; two specimens.

SCOPULA EPISTICTA n.sp.

ἐπιστικτος, dotted.

♂. 18 mm. Head white; face and palpi blackish. Antennae whitish, towards apex grey; in male with tufts of rather long ciliations (one and a half). Thorax and abdomen white, the former faintly ochreous-tinged. Legs whitish; posterior tibiae dilated, smooth, tarsi two-fifths. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly rounded, oblique; white with scarcely a trace of grey transverse lines; a few black scales near base above dorsum; a black discal dot at end of cell, preceded by another at origin of vein 2; postmedian line represented by minute black dots on veins, that on vein 5 displaced slightly inwards; a terminal series of black dots; cilia white. Hindwings with termen rounded, slightly crenulate; as forewings.

Very like *S. aleuritis* Turn. Distinguished by the blackish dots on wings and the male antennae. In that species they are evenly and moderately ciliated (1).

North Australia: Darwin in March; one specimen received from Mr. F. P. Dodd.

SCOPULA COENONA Turn.

The length of the posterior tarsi of the male is two-fifths not three-fifths as printed in my description (Proc. Lin. Soc. N.S.W. 1907, p. 602).

STERRHA LEPTOCHYTA n.sp.

λεπτοχυτος, slightly suffused.

♂ ♀. 12-16 mm. Head fuscous; fillet white. Antennae pale grey; in male with tufts of rather long cilia (one and a half). Palpi very short, slender; pale grey. Thorax pale fuscous, in female sometimes almost whitish. Abdomen pale grey. Legs ochreous-whitish; anterior pair pale grey; posterior pair without middle spurs and similar in both sexes. Forewings triangular, costa straight to two-thirds, thence strongly arched, apex round-pointed, termen slightly rounded, oblique; whitish with faint grey suffusion, which leaves ill defined narrow transverse whitish fasciae at one-third, two-thirds, and five-sixths; a pale fuscous interrupted terminal line; cilia whitish. Hindwings with termen strongly rounded; as forewings.

A very small and fragile species with extremely indefinite markings.

North Australia: Darwin in October and May. North Queensland: Dunk Island in May. Queensland: Rockhampton in August; Yeppoon in September and October; Eidsvold; ten specimens. I suspect that the specimen from Duaringa identified by Meyrick as *E. plumboscriptaria* Christ. in Trans. Ent. Soc. 1897, p. 376, is an example of this species.

STERRHA RELICTATA Wlk.

Cat. Brit. Mus. xxxv., p. 1629.

I am indebted to Mr. L. B. Prout for pointing out to me that *S. ooptera* Turn. is a synonym of this Indian species.

Gen. SOMATINA Gn.

Lep. x., p. 10.

Palpi short, appressed to and not or scarcely exceeding face. Antennae in male ciliated. Posterior tibiae in male dilated, smooth-scaled, grooved internally, containing a tuft of hair from base, and without spurs; in female normally developed and with two pairs of spurs. Forewings with 7, 8, 9, 10 stalked and arising from well before angle of cell, 10 anastomosing with 11 and 9 to form a double areole, 11 from two-thirds. Hindwings with 3 and 4 separate, 5 from middle or from above middle of cell, 6 and 7 separate, connate, or short-stalked.

An Indomalayan genus of small extent, represented in Australia by five species, of which one has not been recorded previously. It is a natural group, though there is some variety of structure in the species.

SOMATINA COSMOPHILA Meyr.

Proc. Lin. Soc. N.S.W. 1887, p. 840.

Antennae of male slightly dentate with fascicles of cilia (1). Posterior tibiae and tuft long; tarsi one-fourth. Hindwings with 6 and 7 connate or short-stalked.

Queensland: Emerald; Toowoomba; Injune. New South Wales: Murrurundi; Newcastle; Sydney. Victoria: Kewell.

SOMATINA RUFIFASCIA Warr.

Novit. Zool. 1896, p. 379.

Unknown to me.

North Queensland: Cooktown.

SOMATINA MACULATA Warr.

Novit. Zool. 1898, p. 244. *S. sordida* Warr. ibid, p. 244.

♂ ♀. 30-32 mm. Head fuscous. Palpi whitish, posterior surface fuscous. Antennae pale grey; in male with fascicles of cilia (1). Thorax white. Abdomen whitish; sometimes with some ferruginous or fuscous scales or spots on dorsum. Legs white or whitish; posterior tibiae and tuft long, tarsi two-thirds, slender. Forewings triangular, costa in male straight to two-thirds, thence arched, in female evenly arched; whitish with very faint grey-whitish markings; a minute blackish discal dot; very slender median, postmedian, and subterminal lines; a submarginal shade with crenated posterior edge; a slender terminal line; frequently dorsal ends of lines and two subapical spots ferruginous-fuscous; cilia grey-whitish. Hindwings with termen moderately rounded; 7 arising separately from above angle of cell; discal dot, colour, and markings as forewings, but without ferruginous-fuscous additions.

Variable; the form without dark markings is *sordida* Warr.

North Queensland: Cape York; Townsville. Queensland: Duaringa; Eidsvold.

SOMATINA EURYMITRA Turn.

Trans. Roy. Soc. S.A. 1926, p. 124.

Male unknown. Hindwings with 6 and 7 connate.

SOMATINA TURBATA Wlk.

Cat. Brit. Mus. xxiv., p. 1098. Hmps. Moths Ind. iii., p. 465.

♂ ♀. 40-42 mm. Head grey; face reddish-fuscous. Palpi fuscous-reddish; beneath ochreous. Antennae grey; in male with tufts of long cilia (3). Thorax pale grey sometimes slightly greenish-tinged. Abdomen pale grey; apex reddish-fuscous; tuft ochreous. Legs reddish-ochreous; posterior tibiae and tuft in male short, first tarsal joint equally dilated and nearly as long; pale ochreous. Forewings triangular, costa straight to three-fourths, thence arched, apex rectangular, termen slightly rounded, slightly oblique; pale grey; markings dark reddish-fuscous in male, paler in female; a narrow triangular patch containing pale striae on dorsum near base reaching to cell; discal spot lunate, oblique; terminal area except near costa dark, extending to termen beneath apex, this extension is cut by a whitish line, which borders the dark patch posteriorly. showing two strong teeth reaching termen in middle and between this and tornus respectively, its lower end incurved; a dark terminal line; cilia reddish-grey with whitish bars. Hindwings with an acute projecting angle on vein 4; 6 and 7 connate; grey minutely strigulated with whitish, in female reddish; a white discal dot at one-third on an obscure transverse dark line; a dark irregular dentate postmedian line; a whitish line from apex with an acute tooth reaching margin below middle, and a second nearly reaching it shortly beneath, ending on dorsum near tornus; the margin beyond this line except towards costa is grey; cilia as forewings. Underside wholly orange-ochreous.

North Queensland: Cape York in June, October, and November (W. B. Barnard). Also from Borneo, Malay Peninsula, and India.

Fam. GEOMETRIDAE.

CENOCHLORA QUIETA Luc.

C. quantilla Turn. (P.L.S. N.S.W. 1910, p. 574) was based on a single specimen from Townsville, differing from typical *C. quieta* in the absence of reddish discal dots and bases of cilia. An examination of a long series from Emerald, Brisbane, Rosewood, Toowoomba, Dalby, Bunya Mts., Injune, and Milmerran has shown that these differences are inconstant, and I now regard the latter name as a synonym.

EULOXIA MERACULA n.sp.

meraculus, pure, unmixed.

♀. 24 mm. Head green; fillet whitish; face dark reddish. Palpi 1; green. Thorax green. Abdomen green; towards apex mostly whitish. Legs grey; anterior coxae and middle and posterior tibiae green. Forewings triangular, costa scarcely arched, apex pointed, termen slightly rounded, slightly oblique; uniform bright green with somewhat of a yellowish tinge, cilia green. Hindwings with termen gently rounded; whitish-green; edges and cilia bright green.

Apparently near *E. ochthaula* Meyr. which I have not seen, but differs in the absence of any whitish or ochreous tinge on the costa of the forewings, and in the green palpi.

South Australia: Kingscote, Kangaroo Island, in April; one specimen received from Mr. F. M. Angel.

CHLOROCOMA IPOMOPSIS Low.

Trans. Roy. Soc. S.A. 1892, p. 14.

Though I have not seen the type, a careful study of Lower's description has convinced me that *C. symbleta* Turn. (ibid. 1922. p. 273) is probably a synonym.

New South Wales: Adaminaby. South Australia: Mt. Lofty.

ULIOCNEMIS ELEGANS Warr.

Novit. Zool. 1899, p. 28; *cassidara* Pagen. Zoologica xxix., p. 153, *nec* Gn.

♂. 22-24 mm. ♀. 30-32 mm. Head green; fillet snow-white; face green, upper third and lower edge white. Tongue weak. Palpi in male 1, projecting slightly beyond face, terminal joint minute; in female 4, second joint very long, terminal joint one-half; green, lower surface white. Antennae white, pectinations in male 12, in female 6. near apex simple; grey tinged with green. Thorax white; patagia, bases and apices of tegulae, and two posterior dots green. Abdomen white with a pair of longitudinal green stripes. Legs white; anterior and middle pairs spotted with green; posterior tibiae with middle spurs short. Forewings triangular, costa straight to three-fourths, thence arched, apex pointed, termen slightly rounded, oblique; bright green with white markings; a costal streak from one-fifth to four-fifths; antemedian line from one-fifth costa to two-fifths dorsum, angled outwards between veins 1 and 2; postmedian almost straight from four-fifths costa to tornus, slightly dentate beneath costa, sometimes connected with antemedian by a longitudinal line between veins 1 and 2; subterminal incurved from apex to termen between veins 1 and 2, thence again incurved and slightly dentate to tornus, connected with postmedian by three fine interneural lines above middle; termen slenderly white with sometimes two to five blackish dots; a white or whitish-brown tornal spot containing two transverse blackish lines; cilia green-whitish. Hindwings with termen rounded, tornus prominent; colour and cilia as forewings; a small narrow apical blotch anteriorly white, posteriorly whitish-brown mixed with blackish; from this runs a white line to termen above tornus; some discal strigulae and an irregular subterminal line white; a blackish dot on tornus.

North Queensland: Cape York in October and November; Kuranda. Also from New Guinea.

LOPHOTHORAX ALAMPODES Turn.

In the Proc. Roy. Soc. Q. 1939, p. 135, the derivation of the specific name is correctly given, but by an unfortunate misprint that name was incorrectly spelt *alamphodes*.

TERPNA LEPTERYTHRA n.sp.

λεπτερυθρος, faintly red.

♀. 28 mm. Head and thorax pale reddish. Palpi 1¼; pale reddish, at base white. Abdomen ochreous-whitish, near base reddish-tinged; apices of segments fuscous. Forewings triangular costa almost straight, apex pointed, termen rounded, oblique; very pale reddish; antemedian line at ¼, median discal dot, and postmedian line at ¾, pale

fuscous; pale reddish on costa to apex; terminal area grey; an interrupted fuscous terminal line; cilia fuscous, on tornus grey. Hindwings with dorsum long, termen rounded; colour and markings as forewings, but without antemedian line; cilia grey-whitish. Underside similar.

Victoria: Walpeup in March; one specimen received from Mr. Geo. Lyell, who has the type.

Fam. OENOCHROMIDAE.

Gen. AGLOSSOPHANES nov.

ἀγλωσσοφανης, with no visible tongue.

Face smooth. Tongue absent. Palpi moderately long, porrect, thickened with rough scales. Antennae in male with short slender pectinations almost to apex. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 free. Hindwings with 6 and 7 connate, 12 approximated to cell to $\frac{2}{3}$ or $\frac{3}{4}$. Type *A. pachygramma* Low.

One of the *Taxeotis* group, but not agreeing with any described genus, and specially characterised by the absence of the tongue.

AGLOSSOPHANES PACHYGRAMMA.

Epidesmia pachygramma Low. Trans. Roy. Soc. S.A. 1893, p. 154.
Taxeotis pachygramma Turn. Proc. Lin. Soc. N.S.W. 1929, p. 503.

Queensland: Milmerran; Injune. West Australia: Eucla (Lower).

AGLOSSOPHANES ADOXIMA n.sp.

ἀδοξιμος, inglorious.

♂ ♀. 19-21 mm. Head whitish on crown; face dark fuscous. Palpi $2\frac{1}{2}$; dark fuscous. Antennae grey, towards base whitish; pectinations in male $1\frac{1}{2}$. Thorax and abdomen pale grey sparsely sprinkled with fuscous. Legs grey. Forewings triangular, costa straight, apex pointed, termen slightly rounded, slightly oblique; pale grey sprinkled with fuscous; a dark fuscous discal dot, sometimes obsolete; a faint whitish subterminal line, absent in female; a terminal series of dark fuscous dots; cilia grey. Hindwings with termen rounded; grey; a terminal series of dark fuscous dots; cilia grey.

Queensland: Milmerran in March; Injune in April; four specimens.

Fam. ARCTIADAE.

LAMBULA PHYLLODES Meyr.

Proc. Lin. Soc. N.S.W. 1886, p. 699. Hmps. ii., p. 699, *nec* Turn. Proc. Roy. Soc. Q. 1940, p. 52.

I am indebted to Mr. G. M. Goldfinch for sending me examples of this species. Though nearly allied to *L. obliquilinea* Hmps. it is certainly distinct. Both wings are paler and more ochreous than in that species. the hindwings have their apices more broadly rounded, and in the male a broadly suffused median streak of orange-ochreous androconia extends from near base to beyond middle on their upper surfaces.

New South Wales: Sydney; Bulli.

LAMBULA OBLIQUILINEA Hmps.

ii., p. 558, Pl. 35, f. 1. *L. phyllodes* Turn. ibid 1940, p. 58, *nec.* Meyr.

Queensland: Nambour; Brisbane; Mt. Tamborine; Macpherson Range (2,500-3,500 feet). New South Wales: Allyn River.

Gen. XANTHODULE.

The neuration of the forewings is incorrectly given in my revision. Vein 6 is separate, 7 and 8 stalked, 9 and 10 stalked, 11 free. This genus should precede *Philenora*, of which it is a derivative.

POLIODULE MELANOTRICHA n.sp.

μελανοτριχος, black-haired.

♂. 20 mm. Head and palpi blackish. Antennae blackish; pectinations in male 6. Thorax blackish; patagia yellow. Abdomen dark fuscous sprinkled with ochreous hairs; tuft ochreous. Legs blackish; apices of anterior coxae and of middle and posterior femora ochreous. Forewings narrowly triangular, costa straight, apex pointed. termen nearly straight, oblique; blackish with pale ochreous markings; an elongate basal subcostal spot; an irregular somewhat lunate spot on three-fifths costa; a small circular spot between this and dorsum; cilia blackish. Hindwings broad, termen gently rounded; yellow; a broad dark fuscous terminal band, sharply defined and twice indented; cilia fuscous.

West Australia: Westonia, near Perth (Mr. J. Angel); one specimen.

EUTANE MIDDLETONI n.sp.

♂ ♀. 28-30 mm. Head orange. Palpi and antennae dark fuscous. Thorax dark fuscous; patagia and a posterior spot orange. Abdomen yellow, bases of segments fuscous. Legs dark fuscous. Forewings suboval, costa gently arched, termen strongly oblique; deep yellow with dark fuscous markings; five rather narrow transverse fasciae; costal edge dark fuscous except between second and third fasciae; first fascia sub-basal, prolonged on costa and dorsum; second from one-fourth costa to one-third dorsum, slightly bent outwards above middle; third from mid-costa to two-thirds dorsum, straight or slightly bent inwards, from it above middle runs a longitudinal line towards, but not always reaching second fascia; third from three-fourths costa to tornus, close to terminal edge and connected with it at middle and tornus; cilia yellow, on middle and tornus dark fuscous. Hindwings with termen rounded; colour as forewings; a broad fuscous terminal band, narrower towards tornus; cilia fuscous. Near *E. trimochla* Turn., but differing in many details.

New South Wales: Murrurundi in March; three specimens received from Dr. B. L. Middleton.

Fam. NOCTUIDAE.

Subfam. Acronyctinae.

Gen. CONOCRANA nov.

κωνοκρανος, with conical head.

Face with obtuse conical corneous process. Thorax with a large rounded posterior crest. Abdomen with dorsal crests on first four segments. Neuration normal. Allied to *Euplexia*.

CONOCRANA OCHTHERA n.sp.

ὀχθηρος, hummocky.

♀. 34 mm. Head white (palpi missing). Antennae fuscous. Thorax fuscous sprinkled with white. Abdomen grey; crests fuscous. Legs fuscous with whitish rings. Forewings elongate-triangular, costa slightly arched, apex round-pointed, termen rounded, slightly oblique; dark fuscous sprinkled with white; an oblique sub-basal white fascia sprinkled with dark fuscous; an irregular blackish interrupted line from one-sixth costa to one-third dorsum bounds this posteriorly; orbicular and reniform mostly white, narrowly edged with blackish, the former circular, the latter suboblong and larger; a suffused blackish streak from first line along fold and prolonged to termen above tornus; three confluent white tornal dots; second line from two-thirds costa to before tornal dots, blackish, posteriorly with acute dentations traversing a broad white subterminal line; a terminal series of fuscous lunules edged anteriorly with white; cilia fuscous barred with white. Hindwings with termen rounded; ochreous-grey-whitish with pale fuscous discal dot, postmedian line. and terminal band; cilia pale fuscous with white bars.

Queensland: Cunnamulla in January; one specimen received from Mr. N. Geary.

Gen. PACHYTHRIX nov.

παχυθριξ, shaggy-haired.

Tongue strong. Face clothed with rough hairs. Palpi moderate, ascending, not reaching vertex; second joint thickened and rough anteriorly, terminal joint moderate or short, smooth, obtuse. Antennae in male minutely ciliated. Thorax with small anterior and moderate posterior crests; beneath hairy. Abdomen clothed with long hairs especially laterally; a crest on first and sometimes on second segment. Forewings with 8 and 9 connate or stalked from areole. Hindwing neuration normal. Type *L. smaragdistis* Hmps. I was mistaken in attributing this species to *Syntheta* Turn. for it possesses a strong crest on the first abdominal segment. In the species described below the basal crest is small but distinct.

PACHYTHRIX AXIA n.sp.

ἀξιος, worthy of esteem.

♂ ♀. 30-34 mm. Head white partly tinged with green. Palpi dark fuscous, inner surface and apex whitish. Antennae fuscous. Thorax black; patagia green, apices of scales white; bases of tegulae white; a V-shaped white central mark edged externally with green. Abdomen green. Legs black with white rings; external tuft on anterior tibiae white. Forewings elongate-triangular, costa slightly arched, apex rounded-rectangular, termen slightly rounded, slightly oblique; green, sometimes yellowish-tinged in disc, with black and white markings; a short broad obtuse streak on costa from base, interrupted by green and with apex white-edged; a large basal white-edged spot sometimes continued by a short streak to antemedian line; antemedian white, slender, from one-fifth costa to one-third dorsum; a costal series of small black spots, which towards apex are separated by minute white dots; a large irregular triangular black spot, its apex on mid-dorsum, partly edged with white; between this and costa a short black streak containing two white dots; postmedian black, slender, from three-fifths costa outwards, bent at two-thirds transversely, in middle angled inwards to dorsal spot; a large white apical spot; an interrupted black terminal band

from this to tornus; cilia green, apices barred black and white. Hindwings with termen rounded; dark fuscous; cilia fuscous, apices partly whitish.

New South Wales: Ebor in February and March; three specimens received from Dr. B. L. Middleton.

NAMANGANA DITATATA Luc.

N. fulvescens Turn. is a synonym. This species has a small basal abdominal crest. The genus *Diploncphra* Turn, cannot be maintained.

Gen. EREMAULA nov.

ἐρημαυλος, inhabiting the desert.

Tongue well developed. Face not projecting; slightly rough-scaled. Palpi moderate, porrect; second joint exceeding face, shortly rough-haired; terminal joint minute. Thorax and abdomen slender and without crests, the latter smooth-scaled. Forewing with a weak forked median vein in cell; neuration otherwise normal. Hindwings with 5 weakly developed from below middle (two-fifths from 4).

EREMAULA PTILOPLEURA n.sp.

πτιλοπλευρος, with feathered costa.

♀. 26 mm. Head and thorax pale grey. Palpi one and a half; pale grey. Antennae grey. Abdomen ochreous-brown; tuft grey. Legs grey; posterior pair whitish. Forewings elongate-triangular, costa straight, apex pointed, termen slightly rounded, slightly oblique; grey suffused with whitish, costa suffused with fuscous; a broad whitish streak from above middle at one-sixth to apex. its costal edge straight, its dorsal edge just before middle enclosing a grey dot in a small convexity, just after middle emitting two small projections, towards apex emitting a series of fine short whitish streaks; a short longitudinal whitish streak from base of dorsum; whole dorsal area suffused with whitish and traversed by slender neural and broader interneural fuscous streaks; an interrupted fuscous terminal line; cilia grey with fine whitish bars. Hindwings with termen rounded and slightly excavated above middle; grey; cilia whitish with a sub-basal grey line.

Queensland: Cunnamulla in January; one specimen received from Mr. N. Geary

Gen. DINOPRORA Turn.

Trans. Roy. Soc. S.A. 1920, p. 153.

This genus differs from *Omphaletis* Hmps. in not having a central circular depression at the apex of the frontal prominence. I make *D. endesma* Low. the type, and to it I also refer *xerampelina* Turn., *plinthina* Hmps., and *stalidosema* Turn.

DINOPRORA NYCTEREUTICA n.sp.

νυκτερευτικος, suited to the night.

♂ ♀. 28-32 mm. Head and thorax fuscous. Palpi 1. terminal joint minute; fuscous, terminal joint and apex and lower surface of second joint pale grey. Antennae fuscous; ciliations in male two-thirds. Abdomen pale grey. Legs fuscous with whitish rings. Forewings narrowly triangular, costa almost straight, apex rounded-rectangular, termen slightly rounded, scarcely oblique; fuscous; markings obscure,

dark fuscous; a sub-basal line from costa to fold; antemedian line at one-fourth, indented in middle; postmedian slender, dentate, outwardly curved, from three-fifths costa to three-fourths dorsum; orbicular faintly indicated by a pale dot, reniform by two short parallel transverse lines, or both absent; subterminal often absent, or indicated by a series of whitish ochreous dots, a similar terminal series, both these, when present, rest on a variably developed series of longitudinal lines running into termen; cilia fuscous. Hindwings with termen rounded; whitish-grey; cilia grey, apices whitish.

West Australia: Tammin in October; eight specimens.

Subfam. Erastrianae.

PEPERITA EUTHYSTICHA n.sp.

εὐθυστικος, straight-lined.

♂ ♀. 16-18 mm. Head, palpi, thorax, and abdomen fuscous. Antennae fuscous; in male pectinate (2). Legs fuscous; posterior pair grey. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen rounded, oblique; fuscous with dark fuscous transverse lines; an incomplete sub-basal line; a narrow nearly straight whitish fascia from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, edged with dark fuscous lines; orbicular obsolete; reniform large, 8-shaped, whitish outlined by dark fuscous and connected by lines with costa and dorsum; a wavy line from $\frac{2}{3}$ costa to $\frac{3}{4}$ dorsum, edged posteriorly by a whitish shade; a fine interrupted whitish postmedian line; an interrupted terminal line; cilia fuscous. Hindwings with termen rounded; 5 approximated to 4 at origin; fuscous; cilia fuscous.

North Queensland: Cairns, from larvae tunnelling mango tips (G. E. Stephens); two specimens, of which one is in the collection of the Queensland Agricultural Department.

HIMEROIS STEREOCROSSA n.sp.

στερεοκροσσος, straight-edged.

♂. 16-18 mm. Head yellow. Palpi 1 fuscous. Antennae fuscous; ciliations in male minute. Thorax fuscous; patagia, apices of tegulae, and a posterior spot yellow. Abdomen ochreous densely sprinkled with fuscous. Legs fuscous; posterior pair pale ochreous. Forewings triangular, costa slightly arched, apex subrectangular, termen slightly rounded, slightly oblique; yellow with fuscous markings; a short basal costal streak; a narrow terminal fascia with straight anterior edge; cilia fuscous. Hindwings with termen rounded; dark grey; cilia grey.

Queensland: Toowoomba in November; Talwood in November and April; Injune in January and April; six specimens.

Subfam. Sarrhothripinae.

CALATHUSA GLAUCOPASTA n.sp.

γλαυκοπαστος, sprinkled with green.

♂. 30 mm. Head fuscous. Palpi exceeding vertex, terminal joint one-third; whitish. Antennae grey; ciliations in male 1. bristles 3. Thorax fuscous; patagia greenish-tinged; tegulae mixed with white. Abdomen grey partly suffused with whitish. Legs grey mixed with whitish, tarsi fuscous with whitish rings; posterior pair mostly whitish. Forewings moderately broad, triangular, costa gently arched, apex rectangular, termen not oblique, rounded beneath, wavy; grey-suffused

with whitish and sprinkled with fuscous, brown, and green scales; markings dark fuscous; a small basal patch with an acute posterior projection; an outwardly curved line from one-fifth costa to one-third dorsum; between these is a white patch lightly sprinkled with green, a faint wavy outwardly curved median shade; postmedian from two-thirds costa to before tornus, with a rounded subcostal prominence, excavated beneath this, bent inwards and wavy below middle, a longitudinal median streak connects these lines; above this orbicular and reniform are slenderly outlined and grey-centred, the latter followed by a pale brown spot, a strong acutely dentate white subterminal line, cut by an irregular dark streak from beneath apex, and preceded by a fuscous edge and green suffusion; a dentate submarginal line; cilia pale grey, with slender dark fuscous bars. Hindwings with termen rounded; grey-whitish with a broad fuscous terminal band, preceded by a slender line, not reaching tornus; cilia whitish. Very distinct, but nearest *G. polyplecta* Turn.

Queensland: Tweed Heads (Burleigh) in September; one specimen.

CALATHUSA MARITIMA n.sp.

maritimus, frequenting the sea coast.

♂ ♀. 26-30 mm. Head and thorax grey with a few whitish scales; face smooth, naked, surrounded by a circular rim of scales. Palpi slightly over 1, terminal joint very short; whitish-grey. Antennae grey; ciliations in male 1, bristles 2. Abdomen pale grey, base white. Legs grey sprinkled with whitish; posterior pair mostly whitish. Forewings narrow, posteriorly dilated, costa straight to two-thirds, thence arched, apex rounded-rectangular, termen slightly rounded, slightly oblique; 7, 8, 9 stalked from areole; grey finely sprinkled with white, in male sometimes with whitish suffusion in disc, lines slender, fuscous, antemedian at one-third, strongly waved; a median transverse shade; postmedian at two-thirds, angled outwards above middle; some longitudinal fuscous streaks in terminal area; a submarginal fuscous line; cilia whitish. Hindwings with termen rounded; whitish or grey-whitish; cilia whitish. The curious facial structure is found in other species of the genus.

North Queensland: Palm Island in May; Lindeman Island in September. Queensland: Noosa in October and April. Common in the last locality.

Subfam. Acontianae.

EARIAS LUTEOLARIA Hmps.

Mr. A. R. Brimblecombe has bred this species from larvae feeding in pods of *Sterculia quadrifolia*.

Gen. ELIGMA Hb.

This genus should be transferred to the Acontianae next to *Cacyparis* Wlk.

Subfam. Ophiderinae.

CRIOA PERSPICUA n.sp.

perspicuus, clearly marked.

♂ ♀. 22-30 mm. Head fuscous sprinkled with whitish; face with rounded prominence. Palpi 2; fuscous, beneath white nearly to apex of second joint. Antennae fuscous; in male shortly ciliated (1). Thorax

with an expansile median crest; fuscous sprinkled with whitish. Abdomen whitish-grey; a flat crest on first segment dark fuscous. Legs white sprinkled with fuscous. Forewings elongate-triangular, costa nearly straight, apex pointed, termen obliquely rounded; grey sprinkled with fuscous and towards termen suffused with pale brownish; a broad white streak from base to middle reaching on costa to one-fifth, sharply limited beneath by fold, apex obtuse, limited by a dark fuscous line except on costa; a slender fuscous line on vein 1; a large bilobate spot in terminal area outlined with dark fuscous, anteriorly conical, posteriorly incised, its interior mostly grey, but with a small white anterior dot; an inwardly curved line from anterior end of spot towards dorsum. sometimes confluent with margin of streak; a white streak from spot to apex; a fuscous terminal line; cilia fuscous with whitish bars. Hindwings with termen rounded, slightly wavy; ochreous-whitish; a narrow suffused whitish terminal band; cilia white.

Queensland: Cunnamulla in October and November; four specimens received from Mr. N. Geary.

Crioa albifusa n.sp.

albifusus, suffused with white.

♀. 30-33 mm. Head grey; face with rounded prominence. Palpi one and a half; grey. Antennae grey. Thorax with a dense posterior crest; grey; apex of crest fuscous, tegulae white sprinkled with fuscous. Abdomen grey. Legs fuscous with whitish rings; posterior pair whitish. Forewings elongate-triangular, costa straight, apex tolerably pointed, termen slightly rounded, slightly oblique; grey with some fuscous irroration and white suffusion; a sharply defined white mark from base of costa to one-third dorsum; central and costal parts of disc suffused with white; orbicular represented by a minute fuscous dot; reniform incompletely outlined with fuscous and with a central fuscous strigula; postmedian lines fuscous, slender, sinuate, from two-thirds dorsum not reaching costa; a blackish spot above tornus; subterminal line slender, dentate, more or less thickened and blackish towards costa; an oblique blackish apical wedge; a terminal series of fuscous lunules outlined with whitish posteriorly; cilia whitish-grey with fuscous bars. Hindwings with termen rounded; whitish with a broad fuscous terminal band; cilia whitish.

Queensland: Cunnamulla in February; two specimens received from Mr. N. Geary.

Crypsiprora transversilinea n.sp.

transversilineus, with transverse lines.

♀. 26-28 mm. Head and thorax fuscous sprinkled with whitish-grey; face with an acute wedge-shaped prominence. Palpi two and a half; fuscous sprinkled with whitish. Antennae grey. Abdomen grey-whitish. Legs fuscous sprinkled, and tarsi ringed, with whitish; posterior pair mostly whitish. Forewings elongate-triangular, costa slightly arched, apex subrectangular, termen rounded, slightly oblique; grey with fuscous irroration and dark fuscous lines; an incomplete subbasal line; a line at one-third, transverse, slightly wavy, sometimes obsolete; a transverse line from two-fifths costa to mid-dorsum, sometimes double; another from mid-costa to two-thirds dorsum, wavy; a large transverse median spot, varying in form, outlined with dark fuscous; subterminal slender, transverse; followed by a roughly parallel

line from apex to tornus; a finely crenulate terminal line enclosing narrow whitish terminal lunules; cilia grey. Hindwings with termen gently rounded; white; a narrow well-defined fuscous median band; cilia white.

Queensland: Cunnamulla in November and December; two specimens received from Mr. N. Geary.

BARYPHANES MICROSPILA n.sp.

μικροσπιλος, with small spots.

♂. 40 mm. Head, palpi, and thorax fuscous. Antennae ochreous-brown; in male dentate with paired lateral tufts of short cilia. Abdomen whitish-ochreous sprinkled with fuscous; tuft fuscous. Legs fuscous. Forewings elongate-triangular, costa straight, apex acute, termen obliquely rounded, sinuate beneath apex; fuscous; two brown-whitish dots, outlined with dark fuscous, beneath costa, at one-fourth and middle; a dark postmedian line faintly indicated; a more distinct interrupted dentate subterminal line; cilia fuscous mixed with crimson, apices whitish. Hindwings with termen rounded; whitish; towards termen sprinkled with fuscous; cilia grey-whitish.

West Australia: Ravenswood, near Perth, in June (M. J. Angel); one specimen.

Fam. LASIOCAMPIDAE.

PORELA CERAUNIAS n.sp.

κεραυνιας, thunderstruck.

♂. 47 mm. Head brown-whitish. Palpi dark fuscous, beneath brown-whitish. Antennae whitish; pectinations in male 10, fuscous. Thorax brown-whitish with some median fuscous suffusion. Abdomen fuscous-brown; posterior margins of terminal segments and tuft brown-whitish. Legs brown-whitish; tarsi fuscous with whitish rings. Forewings triangular, costa straight to near apex, apex rounded, termen obliquely rounded; brown-whitish with dark brown markings; a short median streak from base, sometimes blackish; costal and dorsal areas brownish-suffused; a whitish streak above middle from near base to one-third ending in a discal dot; from this a dark brown streak with two finer streaks above it, all ending on postmedian line; a slender sharply dentate postmedian line from two-thirds costa, at first transverse, bent inwards below middle, thence no longer dentate, but inwardly oblique to one-third dorsum; a short dark brown oblique streak from apex; a small blackish spot on tornus; terminal area grey-suffused with two or three very fine short longitudinal blackish lines; cilia whitish with dark brown bars, which extend inwards as lines on veins. Hindwings with termen strongly rounded; brown with suffused paler median and terminal lines; cilia as forewings.

West Australia: Ravenswood, near Perth, in July (Mr. J. Angel); two specimens.

Fam. LIMACODIDAE.

Gen. ANAPAEA Wlk.

In my revision of this genus in Proc. Lin. Soc. N.S.W. 1926, p. 450, I recognised one species only. The study of further material has convinced me that what I then regarded as geographical races are really two distinct species, which need to be described separately.

ANAPAEA DENOTATA Wlk.

Cat. Brit. Mus. xxxii., p. 474.

♂. 18-23 mm. ♀. 28-30 mm. Head and thorax reddish-brown partly mixed with pale ochreous; face and palpi mostly pale ochreous. Abdomen reddish-brown; towards apex pale ochreous. Forewings narrowly oval-triangular, apex broadly rounded, termen as long as or longer than dorsum, very obliquely rounded; reddish-brown, darker in male; a whitish transverse stria near base, partly obsolete in female; a series of three dark spots outlined with ochreous between mid-dorsum and cell, in female less distinct; a grey costal suffusion containing three dark dots beneath costa beyond middle, in female less distinct and the grey suffusion replaced by pale ochreous; apex suffused with grey in male, with pale ochreous in female; slender median and postmedian lines, grey in male, pale ochreous in female; a grey submarginal line, broad towards costa, prolonged to tornus by three whitish dots; cilia pale ochreous with brown bars. Hindwings with termen strongly rounded; fuscous-brown in male, ochreous in female; cilia in male as forewings, in female wholly ochreous.

North Australia: Darwin; Katherine. North Queensland: Townsville. Queensland: Brisbane; Tweed Heads. Larvae on the Weeping Fig *Ficus benjaminea* (F. H. Taylor). Walker's type was from Moreton Bay.

ANAPAEA TRIGONA n.sp.

τριγωγος, three-cornered.

♂. 26-32 mm. ♀. 35 mm. Head and palpi ochreous; vertex sometimes grey with reddish-brown centre. Thorax reddish-brown; tegulae whitish sometimes mixed with grey. Abdomen reddish-brown; tuft whitish. Forewings triangular, apex rounded-rectangular, termen as long as or shorter than dorsum, slightly rounded, moderately oblique; pale brownish-ochreous partly suffused with grey, or sometimes reddish-brown with grey suffusion on costa; three reddish-brown spots partly outlined with whitish in a line from dorsum beyond middle to cell; subterminal and submarginal lines grey, obscure; cilia whitish, apices grey. Hindwings with termen strongly rounded; pale ochreous, or sometimes reddish-ochreous; cilia whitish, apices sometimes grey.

Queensland: Toowoomba; Dalby; Goondiwindi. New South Wales: Ebor; Murrurundi; Sydney; Mittagong; Jervis Bay. Victoria: Melbourne; Sea Lake. West Australia: Perth.

SUSICA BARYMORPHA n.sp.

βαρυμορφος, heavily built.

♂. 38 mm. Head and thorax brownish-grey. Palpi whitish sprinkled with fuscous. Antennae grey-whitish; pectinations in male 5, becoming gradually shorter towards apex and ceasing at three-fourths. Abdomen brown-whitish. Legs whitish-grey; middle and posterior tarsi dark fuscous. Forewings broadly triangular, costa slightly arched, apex rounded, termen rounded, not oblique; dark grey, towards base with brownish suffusion and a few scattered fuscous scales; a dark fuscous discal spot at two-thirds; cilia dark grey. Hindwings with termen strongly rounded; basal and dorsal areas white; a large grey-brown terminal blotch; cilia as forewings.

North Queensland: Lake Barrine (Atherton Tableland) in January; one specimen received from Mr. E. J. Dumigan.

SUSICA IDIOMORPHA n.sp.

ἰδιομορφος, of peculiar shape.

♀. 35 mm. Head dark brown. Palpi 1; reddish-brown. Thorax dark brown; bases of tegulae pale yellow. Abdomen brown, towards apex ochreous. Legs brownish-ochreous. Forewings strongly dilated between base and middle, thence triangularly constricted, costa strongly sinuate, apex obtusely pointed, termen slightly rounded. very oblique, as long as dorsum, dorsum rounded; brown; costal edge orange-ochreous; a pale yellow blotch occupying costal half of base and connected by a line above middle with a yellowish suffusion in terminal area; two strongly oblique dark brown lines; first from two-thirds costa, at first outwardly oblique, but soon acutely angled and sinuate to one-third dorsum; second from five-sixths costa, at first transverse, but soon curved and nearly straight to two-thirds dorsum; cilia brown. Hindwings rather narrow, termen rounded; pale ochreous suffused with brown towards dorsum; cilia concolorous.

Probably protectively coloured to resemble a withered leaf. Its peculiar shape suggests that further material may justify the formation of a new genus.

North Queensland: Lake Barrine; one specimen received from Mr. E. J. Dumigan.

Fam. COSSIDAE.

Gen. SYMPYCNODES Turn.

This genus is a derivative from *Xyleutes,* from which it differs in the median vein of forewings being unbranched, so that there is no median cell. In the hindwings the median vein either divides shortly before the end of the cell, or its lower branch fails to chitinise, leaving it a single vein. This variation is found in both species.

SYMPYCNODES TRIGONOCOSMA Turn.

Trans. Roy. Soc. S.A. 1932, p. 195.

I have a second example from the Bunya Mts. (3,500 feet) in March.

SYMPYCNODES RHAPTODES n.sp.

ῥαπτωδης, embroidered.

♂ ♀. 36-46 mm. Head and thorax fuscous or grey. Antennae grey; antennal pectinations in male 3, apical half simple. Abdomen grey. Forewings narrow, costa slightly arched, apex rounded, termen obliquely rounded; pale grey with very numerous dark fuscous strigulae closely and generally distributed; a discal dot at $\frac{2}{3}$; cilia grey. Hindwings and cilia grey.

New South Wales: Nambucca Heads in February; Mittagong in January; four specimens.

Fam. THYRIDIDAE.

STRIGLINA ACROCYPHA n.sp.

ἀκροκυφος, with apical hook.

♂. 28 mm. Head whitish-grey. Palpi ascending, slightly over 1, terminal joint very short; whitish-grey. Antennae whitish-grey; ciliations in male minute. Thorax white; patagia whitish-grey. Abdomen and legs white. Forewings triangular, costa straight almost to apex, apex acute, slightly produced, termen rounded, sinuate beneath apex,

scarcely oblique; white; a slightly sinuate brownish-ochreous line from three-fourths costa to two-thirds dorsum, shortly extended to form a small costal mark; a few ochreous strigulae in terminal area; a minute blackish subapical dot; cilia white. Hindwings with termen rounded; white; a very slender transverse ochreous line at one-third, followed by several faint lines and strigulae; cilia white. Underside of forewings with a brownish-ochreous postmedian fascia.

♀. 34 mm. Head, palpi, abdomen, and legs yellowish. Wings yellow; lines as in male, but with an additional line on forewings from costal mark to termen at one-fourth (indicated on undersurface in male), and with more numerous lines and strigulae. How far these differences are sexual or varietal is uncertain.

Queensland: Macpherson Range in January; two specimens received from Mr. E. J. Dumigan.

Rhodoneura hypostilpna n.sp.

ὑποστιλπνος, glittering beneath.

♂. 24 mm. Head grey-whitish. Palpi brown, terminal joint fuscous. Antennae whitish-ochreous annulated with pale fuscous. Thorax ochreous-whitish; patagia fuscous. Abdomen ochreous-whitish sprinkled with grey. Legs, anterior pair fuscous; middle pair brownish; tarsi of both fuscous with whitish rings; posterior pair whitish. Forewings elongate-triangular, costa straight to just before apex, where it is strongly arched, apex acute, termen sinuate beneath apex, obtusely bent on vein 3, oblique; whitish finely reticulated, and costa strigulated, with fuscous-brown; in this network several transverse lines can be distinguished; first at one-fourth; second at one-third, double, approximated or confluent in disc diverging towards margins; third from two-thirds costa to tornus, single on costa but dividing shortly beneath into two parallel lines; a Y-shaped mark from costa before apex to termen; cilia brown, apices fuscous. Hindwings with termen strongly bowed on vein 3; colour and reticulation as forewings; some fuscous suffusion at apex, cilia as forewings. Underside of forewings with a slender black line from near base on upper margin of cell, giving off from its base a shorter but somewhat thicker line, both interrupted by glittering points of brilliant metallic reflections; fine blackish lines on bases of veins 7, 8, 9, 10 spangled at bases only. These recall similar but differently arranged markings of *R. submicans* Warr. (*crypsilitha* Turn.).

Queensland: Noosa in April; one specimen.

Fam. PHYCITIDAE.

Paramatta ensiferella Meyr.

Macrochilota araeosticha Turn. is a synonym.

New South Wales: Ben Lomond (4,500 feet). Victoria: Melbourne; Castlemaine.

Tylochares proleuca Low.

T. hemichionea Turn. is a synonym.

North Queensland: Cairns; Townsville. Queensland: Caloundra; Brisbane. New South Wales: Deniliquin.

Fam. GALLERIADAE.

Gen. MECISTOPHYLLA Turn.

My definition of this genus (Proc. Roy. Soc. Q. 1936, p. 61) requires some amendment. In the female veins 4 and 5 of the forewings are stalked, and 6 may be either connate or stalked with 7, 8, 9. It should also be noted that the thorax has a posterior crest..

MECISTOPHYLLA STENOPEPLA Turn.

I have received two females taken by Mr. W. B. Barnard at Injune in March.

MECISTOPHYLLA AMECHANICA n.sp.

ἀμηχανικος, simple.

♀. 22-24 mm. Head and thorax whitish sprinkled with fuscous or wholly fuscous. Palpi in female 5; fuscous. Antennae and abdomen grey. Legs fuscous; posterior pair grey-whitish. Forewings very narrow, costa strongly arched, apex pointed, termen extremely oblique; grey with some fuscous irroration; a blackish discal spot beyond middle, sometimes surrounded by whitish suffusion; a terminal series of dark fuscous dots; cilia grey with whitish points. Hindwings with termen nearly straight, apex pointed; pale grey; cilia pale grey.

Queensland: Injune in November and April; two specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Gen. DINOPLEURA nov.

δινοπλευρος, with rounded costa.

Face with strong anterior tuft of scales. Tongue and maxillary palpi absent. Labial palpi in male very short, in female long. Thorax without crest. Forewings in female with cell long ($\frac{2}{3}$); 2 from $\frac{2}{3}$, 3 from angle, 4 and 5 long-stalked, 6 separate, 7 and 8 stalked. 9 absent, 10 and 11 separate. Hindwings with cell closed, discocellulars sharply angled inwards, 2 from near angle, 3 and 4 connate or stalked, 5 absent, 7 anastomosing with 12 for more than half its length.

Nearly allied to *Mecistophylla*.

DINOPLEURA LINEATA n.sp.

lineatus, streaked.

♀. 28-32 mm. Head and thorax grey. Palpi 6; grey. Antennae grey. Abdomen grey, towards apex grey-whitish. Legs whitish sprinkled with fuscous. Forewings elongate-oval, costa strongly arched, apex rounded, termen obliquely rounded; grey with some dark fuscous and whitish irroration; veins outlined by fine blackish lines; cilia grey. Hindwings with termen slightly rounded; pale grey; cilia pale grey.

Queensland: Injune in November and March; four specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Fam. CRAMBIDAE.

PLATYTES BIANGULARIS n.sp.

biangularis, two-cornered.

♂. 42-43 mm. Head and thorax whitish-brown. Palpi $3\frac{1}{2}$; whitish-brown. Antennae brown-whitish. Abdomen brown-whitish. Legs whitish. Forewings elongate, costa strongly arched, apex rectangular, termen straight to vein 4, there bent at a right angle, thence

very strongly oblique to tornus; whitish-brown sparsely sprinkled with fuscous, postmedian dorsal area suffused with grey-whitish; a faint fuscous line from $\frac{2}{5}$ costa to $\frac{2}{5}$ dorsum; a similar line from $\frac{4}{5}$ costa, curved inwards and sinuate to $\frac{4}{5}$ dorsum; cilia grey-whitish, above angle with fuscous apices. Hindwings with termen slightly sinuate; brown-whitish; cilia grey-whitish.

Allied to *P. idioptila* Turn. I suspect that both are internal feeders.

Queensland: Injune in October; two specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

TALIS COTYLOPHORA n.sp.

κοτυλοφορος, carrying a saucer.

♂ ♀. 24-25 mm. Head and thorax brownish. Palpi 6; grey, lower surface white. Antennae grey; pectinations in male 1. Abdomen whitish or whitish-grey. Legs grey; posterior pair whitish. Forewings elongate-triangular; costa slightly arched, apex pointed, termen straight, slightly oblique; brownish-grey; a slender white curved median line from $\frac{1}{3}$ to $\frac{2}{3}$, its concavity on costal side filled with fuscous; a fuscous costal streak from $\frac{1}{4}$ to $\frac{2}{3}$; a short white median streak from base, some fuscous irroration in continuation of this and also forming lines between veins in terminal area; a very slender white submarginal line from apex to tornus; a fuscous apical suffusion edged posteriorly with white; some blackish dots on termen towards tornus; cilia leaden-grey with a white median line. Hindwings with termen slightly sinuate; pale grey; cilia whitish.

West Australia: Denmark in March and April; six specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

TALIS HAGNODES n.sp.

ἀγνωδης, unmarked.

♂ ♀. 26-32 mm. Head and thorax pale brownish-ochreous. Palpi 9; whitish-grey. Antennae pale grey; in male serrate and minutely ciliated. Abdomen ochreous-whitish. Legs pale grey. Forewings suboblong, dilated posteriorly, costa gently arched, apex subrectangular, termen straight, slightly oblique; pale brownish-ochreous with some sparsely scattered fuscous scales; some minute blackish dots between veins on termen; cilia whitish with a grey median line. Hindwings with termen slightly sinuate; whitish; cilia whitish.

West Australia: Albany in February; Denmark in March; five specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

TALIS ATACTA n.sp.

ἀτακτος, confusedly marked.

♂. 26 mm. Head fuscous-brown. Palpi 4; fuscous-brown, lower surface except apex whitish. Antennae fuscous; basal joint white. Thorax fuscous-brown with a pair of white longitudinal lines behind patagia. Abdomen ochreous-brown. Legs fuscous; posterior tibiae except apex whitish. Forewings narrowly triangular, costa incurved, apex pointed, termen straight, slightly oblique; fuscous-brown with white markings; a line from base along fold to $\frac{1}{3}$, there acutely angled inwards, outwards, and again inwards to mid-dorsum; a short subdorsal line beyond this; a broader subcostal line from $\frac{1}{8}$ to $\frac{2}{3}$, curved to approach

costa at each end; a stout oblique line from $\frac{2}{3}$ disc to tornus; a slender line from apex to termen above tornus; angled inwards and denticulate; cilia fuscous, bases barred with white. Hindwings with termen sinuate; dark grey; cilia grey.

South Australia: Port Lincoln in January (N. B. Tindale); one specimen received from Mr. Geo. Lyell, who has the type.

TALIS PERIPEUCES n.sp.

περιπευκης, sharp.

♂. 20-23 mm. Head and thorax pale brown. Palpi 8; grey. lower surface except apex white. Antennae pale grey; pectinations in male 1. Abdomen whitish. Legs fuscous; posterior pair grey-whitish. Forewings narrowly triangular, costa nearly straight, apex acute, termen sinuate, scarcely oblique; brownish-grey partly suffused with white and partly sprinkled with fuscous; a white streak from base to near apex, its costal edge pale ochreous-brown; on lower edge of this a fuscous line; a blackish dot in disc at $\frac{2}{3}$; dorsal area white with fuscous irroration and some pale ochreous streaks on veins; a pale ochreous subterminal line separated by a narrow white edge from a dark fuscous submarginal line; a white terminal line containing some triangular blackish dots; cilia grey with a whitish median line. Hindwings with termen slightly sinuate; whitish; cilia whitish.

Nearest *T. invalidella*, which it approaches in shape of forewings.

West Australia: Albany in March; six specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Fam. SCHOENOBIADAE.

The genus *Chionobosca* Turn., described as one of the *Crambidae*, rightly belongs to this family. In neuration it agrees with *Schoenobius*, but differs in the sharply conical frontal process.

Gen. STHYPHLOLEPIS Hmps.

This entirely Australian genus is remarkable for the large size of all its species, which without exception are internal feeders. Mr. W. B. Barnard bred about fifty specimens of *S. agenor* Turn. from a single log of *Capparis sp.*

STYPHLOLEPIS LEUCOSTICTA Hmps.

Ann. Mag. Nat. Hist. (9). iv., p. 318 (1919).

♂. 50 mm. Head pale red. Palpi $3\frac{1}{2}$; fuscous-brown, white, except terminal joint, beneath. Antennae grey, extreme base white. Thorax grey-brown with a central pale red streak behind patagia. Abdomen grey-brown. Legs white; internal surface of anterior pair grey. Forewings elongate-triangular, costa straight to middle, thence sinuate, apex acute, slightly produced, termen bisinuate, oblique; 6 and 7 separate; pale grey suffused with reddish except towards costa and termen; a snow-white circular sub-basal spot slightly below middle; a fuscous line from $\frac{2}{5}$ costa to $\frac{2}{5}$ dorsum, outwardly curved; a fuscous discal dot beneath costa beyond middle; a fuscous line from $\frac{7}{8}$ costa to $\frac{3}{5}$ dorsum, very slightly sinuate; cilia dark fuscous with a white dot above tornus. Hindwings with termen rounded; white; terminal area grey with a fine fuscous subterminal line; cilia grey, on tornus and termen white.

Queensland: Injune in February; two specimens received from Mr. W. B. Barnard. North-West Australia: Roeburne; Sherlock River.

STYPHLOLEPIS ERYTHROCOSMA n.sp.

ἐρυθροκοσμος, decorated with red.

♂ ♀. 35-40 mm. Head pale red. Palpi in male 3½, in female 4; fuscous, beneath white except terminal joint. Antennae fuscous. Thorax grey with broad red median streak. Abdomen pale grey. Legs white; internal surface of anterior pair grey. Forewings elongate-triangular, costa straight to near apex, apex subrectangular, termen strongly bowed on vein 3; 6 and 7 separate; grey sparsely sprinkled with fuscous; an obscure discal dot at ⅝; a faint fuscous line from ⅝ costa to ¾ dorsum, outwardly curved above middle, beneath straight; cilia fuscous. apices white. Hindwings with termen rounded; white with a large grey apical blotch; cilia fuscous, on tornus and dorsum white.

Queensland: Injune in November and January; two specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

STYPHLOLEPIS DELOPASTA n.sp.

δηλοπαστος, distinctly sprinkled.

♂. 32-36 mm. Head and thorax whitish-grey. Palpi 5; whitish-grey, beneath white towards base. Antennae, abdomen, and legs whitish-grey. Forewings narrow, elongate, costa straight to near apex, slightly incurved before apex, apex rectangular, termen rounded, oblique; 6 and 7 short-stalked; whitish-grey sparsely but uniformly sprinkled with blackish; cilia fuscous. apices white. Hindwings with termen gently rounded, grey-whitish; cilia whitish with faint grey median line.

Queensland: Injune in November and December; four specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Fam. PYRALIDAE.

GAUNA FULIGINOSA n.sp.

fuliginosus, dark.

♀. 27 mm. Head and thorax whitish with slight fuscous irroration; pectus white. Palpi two and a half, terminal joint short; fuscous, lower surface except apex white. Maxillary palpi filiform. Abdomen dark fuscous, apices of segments white. Legs fuscous sprinkled with white. Forewings narrowly triangular, costa straight, apex nearly rectangular, termen rounded, slightly oblique; dark fuscous sprinkled and suffused with white leaving dark markings; a transverse sub-basal line; second line at one-third, closely followed by a parallel line; median area mostly whitish with a subcostal discal mark beyond middle; a fourth line from three-fourths costa to tornus, edged whitish posteriorly; terminal area mostly fuscous; cilia fuscous. Hindwings with termen slightly rounded; 7 anastomosing with 12 almost to margin; fuscous; cilia white, bases fuscous.

New South Wales: Murrurundi in December; one specimen received from Dr. B. L. Middleton.

Gen. ECNOMONEURA nov.

ἐκνομονευρος, unsually veined.

Face with rounded prominence. Tongue well developed. Labial palpi moderately long, ascending, appressed to face. rather stout, smooth-scaled; terminal joint as stout as second, short, with rounded apex. Maxillary palpi short, rather stout, obtuse. Forewings with 2 from near angle, 3 approximated to 4 and 5, which are connate from

angle, 6 from near upper angle, 7, 8, 9 stalked from angle, 10 absent, 11 from shortly before angle. Hindwings with cell long (about three-fifths); 2 from four-fifths, 3 and 4 connate, 5 absent, 6 from upper angle, 7 anastomosing with 12 soon after its origin and for some distance.

Not near any other genus, and especially characterised by the absence of 10 in the forewing (probably coalesced with 9) and 5 of hindwing (probably coalesced with 4).

ECNOMONEURA SPHAEROTROPHA n.sp.

σφαιροτροφος, nourished inside a ball.

♂ ♀. 30-34 mm. Head whitish, in female pale grey. Palpi pale grey. Antennae fuscous. Thorax grey sprinkled with fuscous, in centre blackish. Abdomen grey sprinkled with white; a basal spot blackish; underside white. Legs white sprinkled with fuscous; anterior pair fuscous with white rings; middle tibiae with a subterminal blackish ring. Forewings rather narrow, posteriorly dilated, costa gently arched, apex rectangular, termen in male nearly straight, in female strongly sinuate; grey sprinkled with fuscous; markings dark fuscous; a strong oblique line from one-fourth costa to one-third dorsum; a short median transverse mark in disc beneath costa; a bisinuate line from costa before apex to three-fourths dorsum, closely followed by a less distinct and sometimes interrupted parallel line; a submarginal line; cilia grey. Hindwings broad, termen gently rounded; white; a slight apical fuscous suffusion; a fuscous terminal line not reaching tornus; cilia white with a fuscous sub-basal line.

Queensland: Cunnamulla in September; five specimens received from Mr. N. Geary, who obtained them from larvae feeding in galls, locally known as "bloodwood apples," produced by a coccid, which Mr. Brimblecombe has identified as *Cystococcus pomiformis*, on the desert bloodwood, *Eucalyptus terminalis*.

I am indebted to Mr. Geary for the following notes. This gall is found on the small branches of the bloodwood growing in the Cunnamulla district. The gall grows in some cases as large as a cricket ball, but the average size is that of a billiard ball. The outer coat is very rough and hard. This is lined internally with a soft white coating about a quarter of an inch thick resembling the inner coating of a coconut. At its upper end is a minute opening. The cavity is partly filled by the coccid, which appears to be a bag of fluid about half an inch thick (but varying according to the size of the gall). It is attached at both ends, the head being at the base and the sharp point of the tail in the small opening at the top. On the side of some of the mature galls there was a round hole from one-sixteenth to one-eighth of an inch in diameter. When these galls were opened they were found to contain the larvae of a moth, sometimes as many as eight in one gall. These larvae consume the soft inner lining of the gall, and pupate in the cavity among excreta and silken web.

Cunnamulla is situated in the arid plains of Western Queensland, where protection from drought is a cardinal necessity of insect life. This species has solved that problem admirably.

HERCULIA DECOLORALIS Led.

Larvae feeding on *Loranthus* (Mr. H. Hacker).

Fam. PYRAUSTIDAE.

DIATHRAUSTODES METALLOSTICHA n.sp.

μεταλλοστιχος, with metallic lines.

♀. 18 mm. Head white. Palpi grey; base and extreme apex white. Antennae grey. Thorax white; apices of tegulae yellowish. Abdomen whitish; base of dorsum yellowish. Legs whitish; anterior pair with dark fuscous rings. Forewings narrowly triangular, costa almost straight, apex round-pointed, termen slightly rounded, oblique; white; a broad grey costal streak ceasing abruptly before apex; an orange-yellow streak edged with fuscous from one-fourth dorsum very obliquely outwards to middle of disc; a narrow orange-yellow terminal band edged with fuscous anteriorly, connected by an orange-yellow fuscous-edged line with costal streak beyond middle; in terminal band is a submarginal silvery streak from apex ceasing abruptly in a broad end above tornus; cilia pale grey with three blackish bars above tornus, on apex yellowish. Hindwings with apex rounded, termen nearly straight; a silvery submarginal line interrupted and not reaching tornus; five blackish dots on middle part of termen; cilia silvery white .

North Queensland: Chillagoe in September; one specimen.

DICHOCROCIS CHLOROTYPA n.sp.

χλωροτυπος, green-marked.

♀. 19-20 mm. Head, palpi, and thorax pale grey. Antennae grey. Abdomen grey; apices of segments whitish. Legs whitish; anterior pair grey. Forewings elongate-triangular, costa straight to ⅘, thence arched, apex round-pointed, termen straight, oblique; pale grey; markings whitish-green; a large triangular spot on costa from near base to middle, anterior edge oblique, dentate, apex nearly approaching ⅓ dorsum; a spot on ⅔ costa; three elongate parallel dots beneath costa before apex; a broad line from ⅘ costa around apex to midtermen; cilia grey, apices white. Hindwings with termen gently rounded; pale grey; cilia as forewings.

North Queensland: Cape York in November; two specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

SYLEPTA OCTASEMA Meyr.

This species has been bred from a larva in banana fruit (J. L. Froggatt).

Gen. MACROBELA nov.

μακροβελος, with long palpi.

Tongue well developed. Face with a short acute anterior projection. Labial palpi straight, porrect, very long (3½-4), with rough projecting scales at base beneath, otherwise smooth-scaled; terminal joint one-fourth, stout, obtusely pointed. Maxillary palpi short, stout, obtusely pointed, not dilated. Antennae smooth, ciliations minute in both sexes. Posterior tibiae with outer spurs one-half. Forewings with 4 and 5 connate, 8, 9, 10 stalked. Hindwings with 5 approximated to 4 at base, 7 anastomosing with 12 for half its length.

I place this next *Sceliodes*, from which it differs in the longer labial palpi, stouter maxillary palpi, and stalking of 10 of the forewing.

MACROBELA PHAEOPHASMA.

φαιοφασμα, a dusky spectre.

♂ ♀. 24-32 mm. Head and thorax grey. Palpi grey-brown. Antennae grey. Abdomen grey-brown with lateral fringe of whitish

scales. Legs white. Forewings triangular, costa straight to three-fourths, thence arched, apex acute, termen bowed on vein 4, slightly oblique; grey; costal edge whitish; a triangular thinly scaled translucent area from costa beyond middle reaching more than half across disc, indented anteriorly: cilia whitish. Hindwings with termen nearly straight; grey with a faintly darker postmedian line; cilia grey.

North Queensland: Kuranda in October; Ravenshoe (Atherton Plateau) in January (F. P. Dodd); two specimens received from Mr. Geo. Lyell, who has the type.

Gen. METALLARCHA Meyr.

This is a natural genus, though it shows some variation in the structure of the frontal process. I propose to drop *Panopsia* Turn. as a synonym.

METALLARCHA CROCANTHES Low.

Phlytaenodes chrysalis Hmps. Ann. Mag. Nat. Hist. (8), xi., p. 522 (1913), is a synonym.

Victoria: Sea Lake. South Australia: Hoyleton; Nantawarra.

METALLARCHA CHRYSITIS n.sp.

χρυσιτις, golden.

♂. 30 mm. Head with a truncate conical projection; yellow. Palpi three and a half; fuscous; yellow beneath. Antennae fuscous. Thorax yellow with a posterior fuscous spot. Abdomen fuscous; bases of segments and tuft yellow. Legs fuscous; posterior pair ochreous. Forewings elongate-triangular, costa straight to near apex, apex pointed, termen slightly rounded, oblique; yellow with fuscous-grey markings; a rather broad costal streak from base, incised at one-sixth, narrowing to a point shortly before terminal fascia; terminal fascia moderate; a short inwardly hooked transverse process from costal streak at two-thirds, its apex touching a circular spot, which is connected to terminal fascia at tornus; cilia yellow. Hindwings with termen moderately rounded; yellow; a V-shaped discal mark and a terminal band, which does not reach tornus, fuscous; cilia yellow.

South Australia: Noora, near Renmark, in October; one specimen received from Mr. F. M. Angel.

MYRIOSTEPHES EUCOSMETA n.sp.

εὐκοσμητος, very neat.

♂. 14-16 mm. Head and thorax greyish-ochreous. Labial palpi two and a half, terminal joint minute; ochreous-fuscous. Antennae with joints strongly dilated and angular at apices, cilia in male one-half; grey. (Abdomen missing.) Legs ochreous-whitish; anterior pair fuscous. Forewings elongate-triangular, costa straight to near apex, apex pointed, termen nearly straight, slightly oblique; greyish-ochreous; two slender fuscous transverse lines; first from one-third costa to one-fourth dorsum, angled beneath costa, thence straight; second from three-fourths costa to three-fifths dorsum, edged with whitish posteriorly, cuved outwards in upper half, thence straight; a white median subcostal discal dot; cilia fuscous with a darker basal line and three whitish bars, above vein 6, above vein 2, and on tornus. Hindwings with termen rounded; ochreous-whitish; a faint postmedian fuscous line; cilia whitish.

Victoria: Beaconsfield (Wandin) in November; two specimens received from Mr. Geo. Lyell, who has the type.

Fam. GLYPHIPTERYGIDAE.

Gen. SAGALASSA Wlk.

Cat. Brit. Mus. v., p. 5, Meyr. Gen. Insect *Glyphipterygidae*, p. 15. Type *S. robusta* Wlk. from South America.

Miscera Wlk. xxviii., p. 457, Meyr. Proc. Lin. Soc. N.S.W. 1907, p. 100. Type *S. resumptana* Wlk

A genus of moderate size confined to the Neotropical and Australian regions (including one species in the Moluccas). The Australian species are difficult to distinguish on account of their general similarity and frequent variability. So much is this the case, that I have found it difficult to determine new species, and have had to examine critically all the known species. In some cases the scaling of the forewings as seen under a low power objective has proved helpful. The following key should be used with caution, not as a short-cut to diagnosis, but as a preliminary help, which needs confirmation by all the characters given for the species, whether here or in their original descriptions. *S. episcota* Low. (Trans. Roy. Soc. S.A. 1903, p. 68) has been omitted, as it is unknown to me, as it was to Meyrick.

1. Forewings with an orange postmedian fascia ..	2	
Forewings without a postmedian fascia	3	
2. Forewings with fascia narrow and well removed from termen	..	.. *homotona*
Forewings with fascia broad, almost touching termen	..	.. *androgyna*
3. Hindwings with orange, yellow, or whitish markings	4	
Hindwings without markings	15	
4. Hindwings orange or yellow with only a terminal band and extreme base fuscous	5	
Hindwings fuscous with orange, yellow, or whitish markings	7	
5. Forewings grey with whitish median streak from base	..	.. *holodisca*
Forewings dark fuscous without median streak ..	6	
6. Forewings with yellowish discal spot	..	*resumptana*
Forewings without discal spot	..	.. *conspersa*
7. Forewings brownish-grey with darker median fascia	..	.. *poecilota*
Forewings without median fascia	8	
8. Hindwings with orange fascia	9	
Hindwings with yellowish or whitish spots	12	
9. Palpi with long rough hairs beneath	..	*mesochrysa*
Palpi clothed with scales or short hairs	10	
10. Antennal pectinations of male 6; forewings without white-tipped scales	..	.. *ambigua*
Antennal pectinations of male not over 3; forewings often with white-tipped scales ..	11	
11. Forewings with whitish discal dot beyond middle, white-tipped scales few or none	..	.. *centropis*
Forewings without discal dot, white-tipped scales numerous	..	.. *orthaula*
12. Hindwing spots elongate, yellowish, separated by fuscous streaks on veins	..	.. *lygropis*
Hindwing spots not elongate, more discrete, whitish	13	
13. Forewings with dorsal and median spots sometimes confluent, subcostal spot well developed ..	14	
Forewings with small dorsal and median spots only	..	.. *micrasta*

14. Forewings dilated posteriorly .. .. *desmotona*
Forewings narrow, scarcely, if at all, dilated .. .. .. *leucopis*
15. Forewings fuscous with slender white or whitish median streak from base .. .. *pammelas*
Forewings without median streak, usually grey .. 16
16. Expanse 18-23 mm.; forewings sprinkled with white-tipped scales .. .. *omichleutis*
Expanse 30-32 mm.; forewings sprinkled with long white-edged scales with central grey stripe .. .. *ampla*

Sagalassa homotona Swin.

Cat. Oxf. Mus., i., p. 36, Pl. 2, f. 18, Turn. Tr. R.S. S.A. 1923, p. 165. *heterozya* Turn. P.L.S. N.S.W. 1913, p. 202.

♂. With abdomen much longer than forewing and terminated by a large tuft of long scales. ♀. Very similar to the following species; forewings in both sexes with white-tipped scales.

North Queensland: Cairns. Queensland: Brisbane.

Sagalassa androgyna Turn.

P.L.S. N.S.W. 1913, p. 203.

♂. Still unknown. ♀. Differs from all other Australian species in having unipectinate antennae; forewings without white-tipped scales.

North Queensland: Claudie River; Cairns. Queensland: Tweed Heads.

Sagalassa poecilota Turn.

Tr. R.S. S.A. 1923, p. 166.

Easily recognised by the brownish-grey forewings with darker median fascia; white-tipped scales present.

North Queensland: Cairns.

Sagalassa holodisca Meyr.

P.L. N.S.W. 1907, p. 105.

Peculiar in the grey colour of forewings and the pale yellow of hindwings extending to base; forewings sprinkled with white-tipped scales, which may form a whitish streak from base broadening into a central suffusion, which may reach the termen.

West Australia: Perth; Tammin; Geraldton.

Sagalassa resumptana Wlk.

xxviii., p. 456. Meyr. P.L.S. N.S.W. 1907, p. 102.
anthomera Low. Tr. R.S. S.A. 1896, p. 162.

Forewings with an ochreous discal dot more or less developed and with scattered white-tipped scales above, beneath yellow except on margins. Hindwings with yellow fascia broad almost reaching base, cilia on tornus wholly blackish. My observation has been limteed to three male specimens from Cape York (Barnard). The last characteristic is not mentioned by Meyrick and Lower, but their specimens may have been imperfect.

North Queensland: Cape York. Queensland: Rockhampton; Duaringa.

Sagalassa conspersa n.sp.

conspersus, sprinkled.

♂. 20 mm. Head fuscous; face finely sprinkled with whitish. Palpi grey above and beneath. Antennae fuscous; pectinations in male

one and a half. Thorax fuscous; tegulae grey or finely sprinkled with whitish. Abdomen grey with seven fine yellowish rings. Legs fuscous; posterior tibiae ochreous-grey. Forewings dilated posteriorly, costa slightly arched, apex rounded, termen rounded, slightly oblique; fuscous with a variable amount of irroration caused by whitish-tipped scales; which are more dense in an irregular band from three-fourths costa to three-fourths dorsum; cilia fuscous; apices grey. Hindwings dark fuscous; a broad transverse yellow fascia leaving base narrowly fuscous; cilia dark fuscous, apices pale yellow except on tornus.

Differs from *S. resumptana* in the forewings being uniformly fuscous except for slight whitish irroration above. and with only slight central ochreous suffusion beneath.

West Australia: Mt. Dale, near Perth, in January; two specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

SAGALASSA AMBIGUA n.sp.

ambiguus, puzzling.

♂. 16-18 mm. Head and thorax dark fuscous. Palpi shortly rough-scaled beneath, not hairy; dark fuscous, beneath white. Antennae dark fuscous; pectinations in male 6. Abdomen dark fuscous with six narrow yellowish rings. Legs fuscous; anterior coxae whitish. Forewings slightly dilated posteriorly, costa slightly arched, apex round-pointed, termen obliquely rounded; dark fuscous sparsely sprinkled with long narrow brown scales in posterior half; cilia fuscous. Hindwings blackish; a yellow median fascia not quite reaching dorsum, broader towards costa; cilia blackish, on tornus apices yellow. Extremely like *S. mesochrysa*, but distinguished by the different palpi.

West Australia: Perth; Waroona in October; three specimens.

SAGALASSA MESOCHRYSA Low.

Tr. R.S. S.A. 1903, p. 68, Meyr. P.L.S. N.S.W. 1907, p. 103.

Always distinguishable from similar species by the hairy palpi; antennal pectinations (6) longer than in any except the preceding species.

West Australia: Perth; Waroona; Pinjarrah; Geraldton.

SAGALASSA ORTHAULA Meyr.

P.L.S. N.S.W. 1907, p. 103.

isomacha Meyr. Ext. Micro., iii., p. 132.

Forewings sprinkled with white-tipped scales and with no discal dot; hindwings with yellow fascia moderate or narrow.

Queensland: Duaringa; Eidsvold. New South Wales: Sydney; Katoomba. Victoria: Melbourne.

SAGALASSA CENTROPIS Meyr.

P.L.S. N.S.W. 1907, p. 104.

Forewings with whitish discal dot but usually without white-tipped scales; hindwings with yellow fascia moderate or narrow.

There are two aberrations in Coll. Lyell, (1) female with a short transverse line from mid-dorsum and a dentate line from two-thirds costa to discal dot, (2) female with unusually distinct discal dot and a similar line from dorsum together with a few white-tipped scales before termen, a character not observed in any other specimen.

SAGALASSA LYGROPIS Turn.

P.L.S. N.S.W. 1913, p. 204.

Antennal pectinations in male 4; forewings with obscure discal dot and a few white-tipped scales towards base; hindwings with three yellowish spots very narrowly separate (at least in male), median spot narrow and elongate, dorsal spot consisting of long hair-scales.

Queensland: Noosa; Stradbroke Island; Tweed Heads. New South Wales: Sydney.

SAGALASSA DESMOTONA Low.

Tr. R.S. S.A., 1896, p. 162. Meyr. P.L.S. N.S.W. 1907, p. 104.

Abdomen sometimes with white rings; forewings dilated posteriorly, with whitish discal dot often connected by a line with mid-dorsum and with a sprinkling of white-tipped scales posteriorly, but no long brown scales as in *S. micrasta*; hindwing spots very distinct, whitish-ochreous or whitish; dorsal and median spots sometimes confluent.

New South Wales: Sydney; Katoomba. Victoria: Melbourne; Beaconsfield. West Australia: Albany; Waroona.

SAGALASSA LEUCOPIS Meyr.

P.L.S. N.S.W. 1907, p. 102.

14-20 mm. Head, thorax, and antennae blackish. Palpi blackish; lower surface and a median ring on terminal joint white; in one example wholly white. Abdomen blackish with a sub-basal and several post-median white lines. Legs blackish; posterior tarsi with two white spots on dorsum. Forewings narrow, scarcely dilated, costa nearly straight apex rounded, termen oblique; blackish sparsely sprinkled with white-tipped scales; these form a postmedian discal spot suffusedly connected with dorsum, or sometimes by a defined line; sometimes a costal dot or short line at three-fourths together with another above tornus; cilia blackish. Hindwings blackish; three snow-white spots; median and dorsal spots approximated or confluent, sometimes forming an incomplete fascia, third spot beneath mid-costa, of variable size and sometimes absent.

The male is still unknown. The species being variable, I have redescribed it.

North Queensland: Cape York. Queensland: Duaringa. New South Wales: Sydney. Victoria: Geelong; Dimboola.

SAGALASSA MICRASTA Meyr.

P.L.S. N.S.W. 1907, p. 105.

Abdomen sometimes with white rings. Forewings with or without discal dot, without white-tipped scales, but with long brown scales. Hindwings with two small whitish spots near base. In one of my examples there is a grey dorsal triangle extending from one-fourth to tornus and almost reaching half across forewing.

West Australia: Perth; York; Waroona.

SAGALASSA PAMMELAS Turn.

P.L.S. N.S.W. 1913, p. 204.

Forewings dark fuscous with white or whitish median streak from base and discal dot; sprinkled with brown scales. Hindwings dark fuscous without markings.

West Australia: Albany; Denmark; Waroona; Perth.

SAGALASSA OMICHLEUTIS Meyr.

P.L.S. N.S.W. 1907, p. 105.

18-23 mm. Forewings light fuscous or grey without markings, but sprinkled with white-tipped scales. Hindwings fuscous with a white discal spot on under-surface only. This last is a distinctive character, but as I have examined two females examples only, I cannot be sure that it is constant.

SAGALASSA AMPLA n.sp.

amplus, large.

♂. 30-32 mm. Head, palpi, and thorax grey. Antennae grey; pectinations in male one and a-half. Abdomen pale grey. Legs grey. Forewings dilated posteriorly, costa straight, apex rounded, termen rounded, slightly oblique; grey suffused, except on margins, with whitish, this being the effect of densely packed long white-edged scales each with a central grey stripe; sometimes an oblique blackish streak from above one-fourth dorsum to beneath end of cell; cilia grey, apices and a fine antemedian line whitish. Hindwings grey; cilia whitish with a grey basal line.

♀. 28-32 mm. Forewings fuscous unevenly sprinkled with whitish beyond middle; sometimes an oblique whitish streak from above one-fourth dorsum to beneath end of cell; the peculiar white-edged scales present, but much less numerous than in male.

Much larger than any of the preceding species. Allied to *S. omichleutis*, but the scaling of the forewings is quite different.

West Australia: Albany in February and March; four specimens received from Mr. W. B. Barnard. One of these is in Coll. Lyell. Type in Queensland Museum.

SIMAETHIS EMPLECTA n.sp.

ἐμπλεκτος, intricate.

♂. 11 mm. Head and thorax pale ochreous-grey, sprinkled with whitish; thorax with a large posterior fuscous spot. Palpi 2; pale ochreous-grey slenderly ringed with white. Antennae with black and white annulations; in male with fascicles of long cilia (5). Abdomen fuscous. Legs fuscous with white rings; middle and posterior tarsi broadly white in middle. Forewings broadly triangular, costa rather strongly arched, apex rounded, termen slightly oblique; tawny brown intricately marked with dark fuscous, pale ochreous, and lines of white irroration formed by white-tipped scales; some whitish irroration at base; a straight transverse whitish sub-basal line, and another similar at one-fourth; a very irregular dentate interrupted pale ochreous line from costa before middle to mid-dorsum, angled outwards beneath costa and in middle and inwards above dorsum, partly edged posteriorly with dark fuscous, and followed by antemedian, subdorsal, and dorsal patches of whitish irroration; a white costal dot at origin of second line, and two approximated at about three-fourths, giving origin to parallel whitish lines angled outwards beneath costa, thence bisinuate to tornus; an incomplete whitish terminal line preceded by dark fuscous irroration; a white apical dot; cilia whitish-grey, bases tawny brown. Hindwings fuscous with slight whitish irroration towards termen; cilia as forewings.

Queensland: Cairns in August; one specimen.

GLYPHIPTERYX AUTOPETES Meyr.

G. lychnophora Turn. is a synonym.

Fam. HYPONOMEUTIDAE.

ETHMIA PSEUSTIS n.sp.

ψευστις, deceiving.

♂ ♀. 28-32 mm. Head white; face black with white dots beneath antennae and white scales on lower edge. Palpi just reaching vertex; white, bases of second and terminal joints black. Antennae black with incomplete white annulations not reaching under-surface; ciliations in male minute. Thorax white, bases of tegulae, an anterior spot, a pair of median, and a pair of posterior spots, black. Abdomen black with median and lateral series of white dots. Legs black with white rings. Forewings elongate, costa moderately arched, apex rounded-rectangular, termen slightly rounded, scarcely oblique; 7 and 8 stalked; white with black markings; costal edge black to near apex; basal dots on costa and dorsum; a sub-basal line from costa to fold; a line of three confluent dots from one-fifth costa to just beyond fold; costal dots at two-fifths and three-fifths; a discal dot before middle forming an equilateral triangle with these; a subdorsal dot at one-fifth; a dot beneath fold at one-third; a dot on fold at three-fifths with another slightly above and beyond; two confluent dots on three-fourths costa connected with an interrupted line towards but not reaching tornus; a tornal dot; a submarginal line around apex and termen, connected by processes with margin, so as to form a marginal series of white dots; connected also with a transverse subterminal discal mark; cilia fuscous, bases white. Hindwings with 5 approximated to 6; white; a dark fuscous apical blotch; cilia white with a median fuscous line, on dorsum and lower half of termen wholly white.

From this species *E. clytodoxa* Turn. differs in the two basal costal lines to fold being replaced by pairs of dots placed obliquely. two obliquely placed dots following costal dot at two-fifths, by the less elaborate terminal markings, and by the terminal joint of palpi being black except at extreme apex. *E. sciagrapha* Low. has the forewings shorter and proportionally broader, an oblique line of approximated or confluent dots from two-fifths costa, the posterior discal dots nearly or quite confluent, and a tornal spot with hooklike extension towards costa.

Queensland: Toowoomba in October; Injune in November and December; three specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

ETHMIA SPORADICA n.sp.

σποραδικος, scattered.

♂ ♀. 21-22 mm. Head black; side-tufts and face white. Palpi black, second joint with median and apical, terminal joint with apical, white rings. Antennae grey with black annulations; ciliations in male short. Thorax pale grey with black spots, two median and one posterior, also a dot on bases of tegulae. Abdomen grey-whitish, ochreous-tinged on dorsum; tuft ochreous; dorsum of fifth and sixth segments in male fuscous. Legs grey-whitish with black rings; naterior pair mostly black; posterior pair mostly grey-whitish. Forewings elongate-oval, costa moderately arched, apex rounded, termen oblique; pale grey with black dots; costal edge black near base; a spot on base of costa emitting a short sub-basal line; subcostal dots at one-third, one-half, and three-fourths; a dot on lower edge of fold near base and another at one-fourth; a subdorsal median dot; a pair of discal dots at three-fourths, the lower slightly posterior; a median subapical dot;

a marginal series of dots from three-fourths costa to tornus; cilia pale grey, bases barred with black opposite two subapical dots. Hindwings and cilia grey. Near *E. heptasema* Turn., but the spots on forewings are more numerous and differently arranged.

Queensland: Bunya Mts. in November; three specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Lactura clitodes Turn.

In my description (Trans. Roy. Soc. S.A. 1932, p. 193) the neuration of the forewings is wrongly stated; 7 and 8 are stalked; 6 separate but approximated to them at origin. In a second male example from Tooloom, N.S.W., the whitish patch on the forewings is absent, being replaced by a slight sprinkling of whitish scales.

Lactura rhodomochla n.sp.

ῥοδομοχλος, rosy-barred.

♂ ♀. 17-20 mm. Head yellow with a pair of red dots on posterior edge. Palpi minute; reddish. Antennae yellow; ciliations in male minute. Thorax red. anterior margin yellow. Abdomen and legs reddish. Forewings suboval, costa strongly arched, apex rounded. termen obliquely rounded; 7 and 8 stalked; yellow with three broad crimson-red transverse fasciae; first basal, posterior edge from one-sixth costa to one-fourth dorsum, angled beneath costa and indented in middle; second median, broad in disc but narrowed on costa and dorsum; third from costa before apex to tornus, more or less constricted in middle, anteriorly angled beneath constriction; cilia yellow. Hindwings with 4 and 5 connate or short-stalked; reddish; cilia reddish.

North Queensland: Cape York in October and April; five specimens received from Mr. W. B. Barnard. Type in Queensland Museum.

Lactura aglaodora n.sp.

ἀγλαοδωρα, a splendid gift.

♀. 40 mm. Head pale yellow. Palpi very short; pale yellow. Antennae whitish. Thorax grey, central area rosy-suffused, anterior margin broadly yellow. Abdomen orange-ochreous. Legs whitish. Forewings suboval, costa strongly arched, apex rounded, termen obliquely rounded; 7 and 8 stalked; grey with longitudinal streaks and a broader band on dorsum rosy; a yellow costal streak to beyond middle, triangularly dilated at one-fourth; terminal area pale yellow, its anterior edge sharply defined from three-fifths costa to tornus, nearly straight but angled on vein 6, on which a reddish line runs for some distance posteriorly; cilia pale yellow. Hindwings with 4 and 5 connate; orange-ochreous except on costa and apical areas, which are whitish; cilia whitish, on dorsum and dorsal half of termen orange-ochreous.

North Queensland: Lake Barrine in January; one specimen received from Mr. E. J. Dumigan.

Thyridectis psephonoma Meyr.

Proc. Lin. Soc. N.S.W. 1886, p. 1046. (Newcastle).

Queensland: Macpherson Range in January; two specimens received from Mr. E. J. Dumigan.

Gen. SCHISTOCYTTARA nov.

σχιστοκυτταρος, with divided cell.

Head with sidetufts of loose spreading hairs on vertex; face smooth. Tongue present. Labial palpi long, ascending, recurved, smooth-scaled; second joint reaching middle of face; terminal joint longer than second, equally stout, acute. Maxillary palpi filiform, porrect. Antennae about three-fifths. Thorax with a rough posterior crest. Tibiae smooth-scaled; inner spurs twice as long as outer. Forewings with chorda and forked median vein in cell, from which all the peripheral veins arise separately; 2, 3, 4, 5 approximated, 6 from middle, 7 to termen. Hindwings broadly ovate; 2 from two-thirds, 3 and 4 separate, 5 from middle, 6 and 7 separate, parallel; a forked median vein in cell.

This genus, which presents some primitive characters in its neuration, does not appear to have any close allies, but perhaps comes closest to *Ethmia.*

SCHISTOCYTTARA NEBULOSA n.sp.

nebulosus, cloudy.

♀. 22 mm. Head, thorax, and abdomen ochreous-whitish. Palpi dark fuscous; extreme apex whitish. Antennae with basal joint long, stout, ochreous-whitish; for an equal length beyond this dark fuscous; beyond this whitish-grey. Legs dark fuscous with white tarsal rings; posterior pair ochreous-whitish. Forewings dilated posteriorly, costa moderately arched, apex rounded, termen rounded, scarcely oblique; white mostly suffused with pale grey and brownish; markings dark fuscous; a short slender costal streak from base; oblong costal spots at one-third, two-thirds, and five-sixths; the rest of costal area brownish with dark transverse strigulae; a few strigulae also in posterior part of disc; an oblong dorsal spot at one-third, its upper anterior angle giving off a short process towards base; a smaller oblong spot beyond middle and a tornal dot; remainder of dorsal area whitish; very faint sinuous fasciae connect second dorsal with first and second costal spots forming a broad V-mark; cilia whitish with broad fuscous bars. Hindwings grey; cilia pale grey, towards tornus whitish.

Queensland: Macpherson Range in January; one specimen received from Mr. E. J. Dumigan.

VARIATIONS IN THE VULVAL LINGUIFORM PROCESS OF HAEMONCHUS CONTORTUS.

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(1 TEXT FIGURE.)

(*Communicated to the Royal Society of Queensland by the President, 26th May,* 1941.)

INTRODUCTION.

It is well known that the vulval linguiform process of *Haemonchus contortus* presents a number of variations in both size and shape. Veglia (1915) describes the normal type of linguiform process in *H. contortus* from sheep as commencing just in front of the vulva, extending backwards in a slightly oblique direction and measuring about 0·75 mm. in length by about 0·25 mm. in width. It is featured in Figure 52 of his monograph. The variations observed by him include (i) an unusually short process measuring 0·25 mm. by 0·17 mm., conical in shape, adhering to the body and slanting to the tip, (ii) a process resembling a pimple-like body, protruding for almost 0·25 mm., sometimes placed anteriorly and sometimes laterally to the vulva, and (iii) females in which the process is entirely missing.

Dikmans (1921) after a study of numerous specimens remarks that "All the anomalies mentioned by Dr. Veglia were observed in our specimens." The four different types are figured in Plate 3 of Dikmans' article.

Finally, certain observers, Mönnig (1928) and the writer (1934), for example, have indicated that in *H. contortus* from cattle the linguiform process is frequently reduced to a small knob.

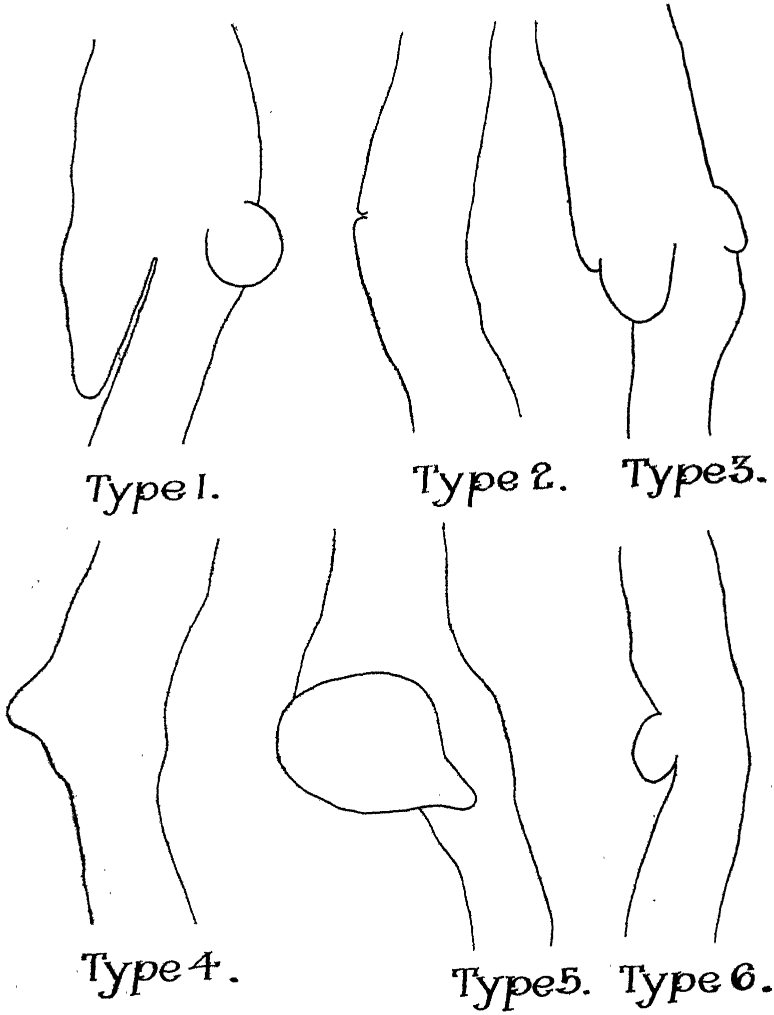
During some recent work on the transference of sheep helminths to cattle and vice versa, the writer had an opportunity of making some observations on the variations that occur in the linguiform process. These are considered of sufficient interest to warrant publication.

EXPERIMENTAL PROCEDURE.

In the experiments yielding the information contained herein, attempts were made to establish infestations of helminths from sheep in five calves reared under worm-free conditions. In addition, the susceptibility of sheep was tested (*a*) to helminths of sheep origin after passage through cattle and (*b*) to cattle helminths, which so far as could be ascertained were of a pure cattle strain. In all series of trials, *H. contortus* was prominent.

OBSERVATIONS.

An examination of a large series of female *H. contortus* from natural infestations in both sheep and cattle revealed no less than six distinct types of variation in the shape and size of the linguiform process. These are figured in Text Figure 7, where they are designated as Type 1, Type 2, &c.



Text Figure 7.
Types of Variation in the Vulval Linguiform Process of *Haemonchus contortus.*

In the following table, the percentages of the respective types occurring in naturally infested sheep and cattle are compared with those found in the calves and lambs infested during the course of the experiments described above.

TABLE I.

VARIATIONS IN THE LINGUIFORM PROCESS OF *H. contortus*.

Host.	No. Examined.	% Type 1.	% Type 2.	% Type 3.	% Type 4.	% Type 5.	% Type 6.	Origin of Infestation.
Sheep ..	706	89·3	5·6	1·0	3·0	1·0	0·1	Natural infestation
Cattle ..	587	4·7	0·3	..	..	0·3	94·7	Natural infestation
Calf 1 ..	253	86·5	11·5	..	0·5	1·5	..	Ovine origin
Calf 2 ..	315	4·0	0·2	..	..	0·6	95·2	At first ovine origin, finally bovine origin
Calf 3 ..	86	88·2	3·5	1·2	2·2	4·2	0·7	Ovine origin
Calf 4 ..	442	4·2	..	0·9	..	0·8	94·1	At first ovine origin, finally bovine origin
Calf 5 ..	134	85·9	14·0	0·1	..	..	..	Ovine origin
Lamb 4..	500	89·4	2·1	3·4	2·1	2·0	1·0	Ovine origin ex Calf 1
Lamb 5..	500	90·1	1·1	3·6	1·2	3·0	1·0	Ovine origin ex Calf 1
Lamb 6..	500	4·8	..	..	..	..	95·2	Bovine origin
Lamb 7..	500	3·0	0·7	0·2	..	..	96·1	Bovine origin

Calves 1, 3 and 5 received *H. contortus* of ovine origin only and the infestations were of 10, 15 and 19 weeks' duration respectively. Calves 2 and 4, after displaying a marked resistance to *H. contortus* from sheep, as indicated by the almost complete elimination of the infestation after a period of 17 weeks, were fed larvae of bovine origin and slaughtered 9 weeks later. Lambs 4 and 5 were killed 6 weeks after infestation with larvae from calf 1, whilst lambs 6 and 7 received larvae of what was considered to be a pure cattle strain.

An examination of the table shows that the great majority of female worms from naturally infested sheep conform to Type 1, and of those from naturally infested cattle to Type 6. The table also reveals that when cattle are infested with an ovine strain and sheep with a bovine strain there is no significant change in the proportions of the respective dominant types. In calves 1, 3 and 5 infested with larvae from sheep for periods of 10, 15 and 19 weeks respectively 86·5 per cent., 88·2 per cent. and 85·9 per cent of the females remained of the dominant sheep type (Type 1), whilst in lambs 6 and 7, given larvae from cattle and infested for 6 weeks, 95·2 per cent. and 96·1 per cent. respectively of the females belonged to the dominant cattle type (Type 6). Calves 2 and 4 infested with larvae from cattle, after losing most of their infestation of sheep origin, gave percentages of 95·2 and 94·1 respectively of Type 6. It is also evident from lambs 4 and 5 which yielded 89·4 per cent. and 90·1 per cent. respectively of Type 1, that passage of an ovine strain through cattle for a period of 10 weeks failed to have any significant effect on the proportions of the dominant ovine type.

In his discussion of the anomalies occurring in the vulval linguiform process, Veglia (1915) remarks "at the time of marked reproductive activity I met with a very large number of rather old female worms showing peculiar differences in the linguiform process." Veglia's inference that reproductive activity and age are associated in some way with the appearance of the linguiform process does not, however, according to the writer's observations, provide a very satisfactory explanation for this variability.

Although the linguiform process is a very variable structure the great majority of those females from sheep possess a fully developed

process, whilst in cattle, most of the females possess a process which is reduced to a small knob. Does this feature indicate that *H. contortus* is in a process of evolution into two distinct species or is it merely an expression of some physiological difference occurring in the two respective hosts? In the writer's experiments cattle *H. contortus* was maintained in sheep for six weeks and sheep *H. contortus* in cattle for up to 19 weeks without any significant alteration in the proportions of the two dominant types. It would appear then, that each type breeds true for at least one generation irrespective of the host, and that if any alteration of, say, Type 6 of cattle when established in sheep to Type 1 does eventually occur, such alteration requires more than one generation.

SUMMARY.

1. A study has been made of the variations which occur in the vulval linguiform process of *H. contortus*. Six distinct types of process were observed. One of these, Type 1, in which the process is fully developed, is dominant in sheep; another, Type 6, in which the process is reduced to a small knob, is dominant in cattle.

2. Infestation of sheep with cattle *H. contortus* for a period of 6 weeks and of cattle with sheep *H. contortus* for periods of 10 to 19 weeks did not result in any significant alterations in the proportions of the two dominant types—that is, Type 6 was dominant in the sheep and Type 1 in the cattle.

3. It is suggested that this phenomenon may indicate an evolution of *H. contortus* into two distinct species or it may be merely a result of some physiological difference between the two hosts. If Type 6, for example, does change eventually to Type 1, when sheep are infested with cattle *H. contortus*, then such a change requires several generations, for each of these two types breeds true for at least one generation irrespective of the host.

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NOTE ON A GROOVED AND POLISHED GRANITE SURFACE NEAR EULO, WESTERN QUEENSLAND.

ARTHUR WADE, D.Sc., A.R.C.Sc., F.G.S.

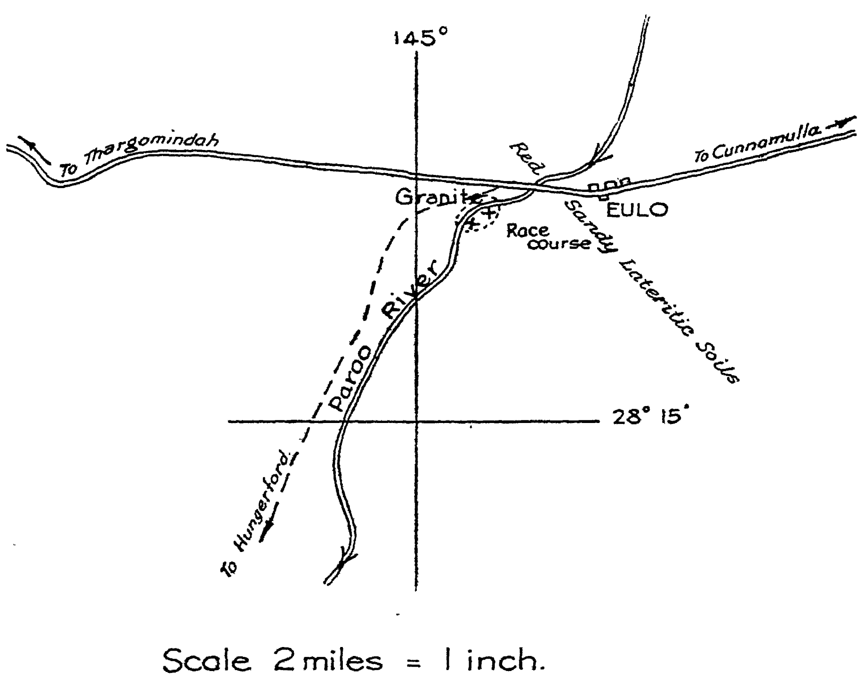
(1 TEXT FIGURE.)

(*Read before the Royal Society of Queensland, 30th June, 1941.*)

1. LOCATION.—The village of Eulo stands in the midst of red sandy plains with occasional low, flat-topped mesas or ridges consisting of rubbly ferruginous laterite, pale yellow ironstone, brown porcellanitic and quartzitic layers. A measured section exposed about 40 feet of these materials. They are the remnants of a sheet which was formerly much more extensive in this part of Queensland.

At Eulo the broad shallow valley of the Paroo River cuts through the plains and, at a distance of about 1½ miles to the south of the village, exposes underlying granite. The granite outcrops occur on both sides of the shallow depression through which the Paroo River runs and are near the western margin of the racecourse. They form a bar in the bed of the river at this place.

2. DESCRIPTION.—The outcrops take the usual form—low hog-backs and rounded boulder-like masses. Evidence of decomposition or weathering, other than exfoliation due to exposure, is slight. The surfaces look as though they had been uncovered in comparatively



TEXT FIGURE 1.

recent times by the scouring action of flood waters. They are becoming more exposed as the cover of soft material is removed. The general old granite surface seems to be one of peneplanation.

One of the hog-backs near the river on its eastern bank is of interest because on its surface are the remnants of a grooved and polished surface. This can be clearly seen in the accompanying photograph. The grooves are broad, shallow, parallel, and maintain a constant direction which, according to the Author's notes, run north-west to south-east (subject to more accurate determination). The polished surface, when examined in the vertical sections provided by its fractured margins, is imposed on a thin white layer of rock flour formed by the powdering of the granite surface below.

3. AGENTS.—How this granite surface came to be grooved and polished in this manner must be a subject for speculation but the occurrence is certainly of scientific interest. Only two agencies seem possible—human or glacial.

(*a*) *Human.*—It is possible that the grooving and polishing has been caused by aborigines in the course of manufacturing and sharpening stone implements. If this be so the matter can be left to students in another field. The Author has seen a number of rock surfaces which have been so used by natives in various parts of Australia but none seem to have had such regularity as appears in this case. Grooves tended to be narrower and deeper and, in some cases, they were observed to cross one another. To wear down and polish a granite surface in the manner shown would take very many years of work. On the other hand, the locality is, perhaps, one which would be regularly frequented by natives as a camping or hunting centre.

(*b*) *Glacial.*—This grooved and polished surface does bear resemblance to the glaciated rock floors which can be seen elsewhere in the world, but if boulder-filled ice was the agency the following questions may be asked:—

(1) Why have no similar surfaces been noted?

(2) When did this glaciation occur?

(3) What form did it take?

(4) Where did the ice come from?

(5) Where are the boulder beds which might be expected in association with such a pavement?

An attempt is made to answer these questions:—

(1) The finding of any glaciated rock surface in Northern Australia could only be a most fortuitous happening. Its characteristic features would be destroyed in a comparatively short space of time after exposure by the action of wind-blown sand and other weathering agencies. It could only be preserved beneath some protecting cover and only found, in most circumstances, if the interval between exposure and discovery was relatively short.

(2) While the preservation of a glaciated floor of Permo-Carboniferous age so far north as south-western Queensland may be within the bounds of possibility since boulder beds

of this age are known to occur in regions further north, considerations of probability suggest more recent origin. Several Australian geologists have submitted evidence, based chiefly on occurrences of erratics, of a Cretaceous Ice Age in Australia. Woolnough and David (1926), however, in marshalling part of this evidence, cannot be more certain with regard to the age of the beds from which erratics noted in Central Australia are derived than that they "may range from about Middle Cretaceous to the base of the Miocene." Howchin (1923), on the other hand, considered that some of these erratics could have been derived from Pre-Cambrian tillites or even tillites of Permo-Carboniferous age, exposures of which had been recently found at no great distance from the principal area described by Woolnough and David.

Large boulders of Devonian limestone found in the Cretaceous sediments of north-western New South Wales suggest transportation by ice (Dun. 1898).

Evidence of glacial action farther to the west in Western Australia, not far from Laverton, have been described by Talbot and Clarke and ascribed to a Cretaceous glaciation but Maitland, in discussing the paper, leaned towards a Permo-Carboniferous origin for the boulder beds dealt with.

(3) There is nothing in the records referred to that provides convincing proof of the existence of land ice in Central Australian regions or in Queensland during Cretaceous times. The most that can be inferred from the evidence available is that icebergs and floes occasionally found their way into the Mesozoic inland seas of Australia towards the close of that era. These may have dropped their burdens of boulders and morainic materials as they drifted northwards and melted.

(4) The Author's personal view is that the South Polar region was near to the southern coasts of Australia in the time of the Permo-Carboniferous glaciation and may have still been much nearer than at present to the end of the Mesozoic Era. Any bergs and floes which drifted into these Mesozoic epicontinental seas were most probably derived from the circum-polar ice sheet of Mesozoic Antarctica.

(5) Remnants of possible boulder beds in Queensland, probably of Upper Cretaceous age, have been described by Jensen (1921). Erratics noted by him were traced along the south-eastern margin of the Great Artesian Basin in southern Queensland and were found to be most numerous in the vicinity of Injune. Wade has also referred to these occurrences but suggested the possibility of derivation from the Permo-Carboniferous horizons which outcrop not far distant to the north. Much of the material forming the accumulations of boulders on this south-eastern margin of the Great Artesian Basin is clearly derived from the former more extensive cover of siliceous "billy," but associated with this are erratic blocks of crystalline igneous rocks.

4. CONCLUSIONS.—Examination of the literature creates a strong impression that much further work is necessary before this Cretaceous Ice Age leaves the nebulous stage to become recognised as a well-established episode in the geological history of Queensland and other parts of Australia.

On such evidence it is impossible to ascribe this grooved and polished surface definitely to glacial action. The alternative agent, the stone-working aborigine, seems at present to be the more probable. In either case the occurrence is worthy of record.

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Note.—For further references see bibliography, Woolnough and David, 1926, pp. 333-334. Most of the works listed above are supplementary.

REACTIONS OF DOMESTIC FOWLS TO HOT ATMOSPHERES.

By N. T. M. YEATES, B.Agr.Sc., D. H. K. LEE, M.D., M.Sc., D.T.M., and H. J. G. HINES, B.Sc., Department of Physiology, University of Queensland.

(PLATE IV. AND 6 TEXT FIGURES.)

(*Read before the Royal Society of Queensland, 30th June, 1941.*)

INTRODUCTION.

Insufficient attention seems to have been given to the general physiology of the domestic fowl, and in no respect is this apparent neglect greater than in that of its reactions to hot atmospheres. In all countries with high summer temperatures, losses of poultry occur from heat effects. This annually recurring loss assumes serious proportions from time to time with the incidence of "heat waves." Thus much loss was incurred in the United States in July, 1936.[3] Our attention was drawn to the problem in Queensland in January, 1940, by a "heat wave" of record proportions. In Table 1 are set out the meteorological records for this period. The losses incurred were estimated at 40,000 birds, valued conservatively at £6,200. To this estimate must be added losses produced by reduction in laying. While Hutt[3] gives a good analysis of field observations in the United States, no experimental enquiry seems to have been conducted. Discussion at a meeting of the National Utility Poultry Breeders' Association in Brisbane produced many suggestions and valuable field observations. The present enquiry was based upon the evidence so obtained and was designed to establish—

(i.) The atmospheric conditions which produce heat effects in fowls;

(ii.) The comparative behaviour of different breeds;

(iii.) The importance of providing drinking water;

(iv.) The effect of the protein level in the diet;

(v.) Practical methods of preventing or reducing heat effects in fowls.

EXPERIMENTAL CONDITIONS AND METHODS.

Only hens were studied. They were kept under normal atmospheric conditions when not required. On the day of experiment they were placed singly into cages and introduced at 9.0 a.m. into the air-conditioning room, in which the required dry and wet bulb temperatures had been produced. During the experiments each bird was confined by itself in a wire cage measuring 14½ inches high x 11 inches x 17 inches. The floor was covered with a ½-inch pine board. The experimental birds were kept in this atmosphere for seven hours or until removed because of collapse or through having reached a rectal temperature of 113 degrees F. Four series of experiments were conducted:—

(i.) Preliminary series.—To produce a partial moult, accustom birds to handling, and establish critical conditions. All experimental birds were given this preliminary treatment.

TABLE 1.

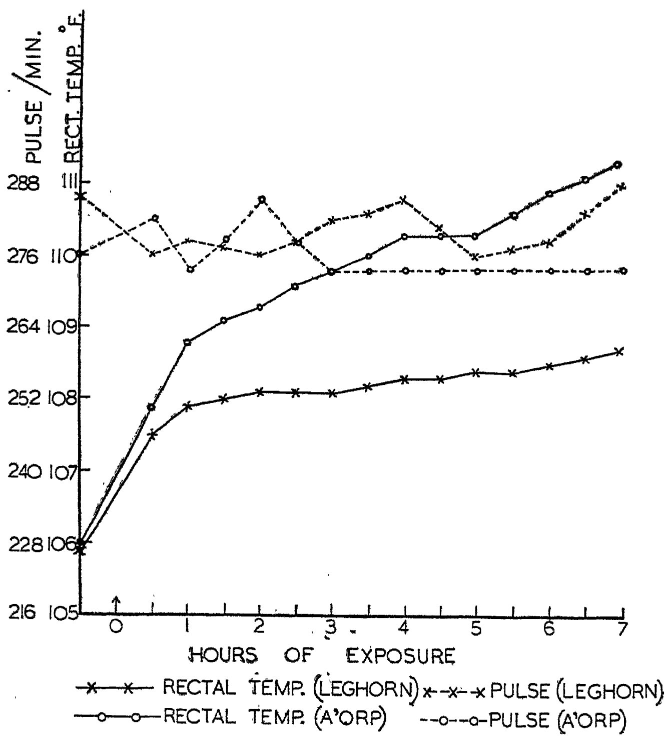
METEOROLOGICAL DATA—JANUARY, 1940. (BRISBANE, Q.).

For two record days:—

Day.	Item.	Min.	9. a.m.	Max.	3 p.m.	9 p.m.
26th ..	Dry Bulb	78·3	92·8	109·8*	105·3	89·3
	Wet Bulb	..	82·2	..	86·3	76·0
	Relative Humidity ..	..	62%	29%	44%	52%
29th ..	Dry Bulb	82·4*	92·0	106·4	105·3	88·0
	Wet Bulb	..	76·5	..	78·7	81·4
	Relative Humidity ..	..	47%	28%	28%	74%

* Records.

Ten successive days over 90 degrees (second longest heat wave on record).



TEXT FIGURE 1.

Reactions of Rectal Temperature and Pulse Rate of Fowls exposed to 100° F., with 65 per cent. Relative Humidity.

(ii.) Effective temperature series.—Using various combinations of dry bulb temperature from 70 to 110 degrees F. and of relative humidity from 25 to 95 per cent., to ascertain the co-operative action of these two atmospheric variables upon the fowl's reactions. Possible combinations were limited below by exterior dew points and above by the workers' capacity to withstand the conditions.

(iii.) Hydration series.—Supplying the birds in successive trials with no water, 15-20 ccs. once an hour, and 15-20 ccs. every half hour, to ascertain the importance of different levels of hydration. Room conditions: D.B. 106 degrees; Rel. Hum. 25 per cent.

(iv.) Protein series.—Keeping the birds for one week before each experiment on a diet in which the protein constituted successively 5, 11, 17, 22, and 28·5 per cent. of the total weight. Room conditions: D.B. 106 degrees; Rel. Hum. 25 per cent. Feeding was continuous up to the time of entering the room.

Only two breeds were used—White Leghorns and Australorps (Plate IV.) The birds used were selected as being within the one breed, of similar and fair average build and nutrition. All were in good health. In later experiments it sometimes became necessary to substitute a fresh bird for one indavertently lost in a previous experiment. Experience had shown by that time that variation between individuals was not great, provided that the partial moult had been obtained by preliminary exposure and handling. Once birds were introduced to a particular series they were not transferred to another series.

In each series, four White Leghorns and four Australorps were used. Results quoted below represent the average of the observations upon the four birds, unless otherwise stated.

All birds not on the special protein diets were maintained over the whole experimental period on a standard laying mash containing 17 per cent. protein to which greenstuff was added. All birds other than those actually being subjected to hydration tests were allowed free water-drinking, both outside and in the experimental room.

The following observations were made in an ante-room under normal atmospheric conditions before commencing each experiment and at suitable intervals in the hot room thereafter—pulse rate, measured by listening with a stethoscope and counted over five-second intervals; rectal temperature, measured by a clinical thermometer held in position; respiratory rate, counted by sight; weight loss, measured on a Sauter balance sensitive to 0·5 gm; general behaviour.

The whole range of experiments described herein was carried out in the four months from winter to spring (July-October). Experiments on the same birds were so spaced that, apart from the initial moult, little chance was given them to build up a long-term acclimatisation. The different experiments of the effective temperature series were also well scattered over this period.

In all experiments the walls of the room were at approximately the same temperature as the air, so that no new radiation factor was introduced, and the air-movement remained constant at an average velocity of 75 feet/min.

TABLE 2.

TEMPERATURE-HUMIDITY GRIDS IN RESPECT OF RECTAL TEMP.

Australorp.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	106·0	106·6	105·8	106·5	107·7	110·1	..	..	..
85 ..	105·1	106·2	105·8	106·3	107·0	107·8	[111·1] 5·8 (2)	..	..
75 ..	104·8	105·5	106·2	106·5	107·2	108·1	[110·3] 6·4 (2)	[120·2] 2·2 (4)	..
65 ..	..	105·0	105·4	106·4	107·4	108·5	109·6	[115] 4·1 (4)	[118·9] 2 (4)
55 ..	..	..	105·6	106·3	106·8	108·4	108·2	[114·9] 3·8 (4)	[120·9] 2 (4)
45 ..	..	..	..	105·8	106·5	107·1	109·0	[114] 4·6 (3)	[119·3] 2·1 (4)
35 ..	..	..	..	..	..	106·6	109·8	[115·2] 3 (3)	[110·9] 4·7 (4)
25 ..	..	..	..	..	..	..	..	[108·8] 6·4 (2)	..

White Leghorn.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	105·8	106·1	106·0	106·0	106·8	107·8	..	..	..
85 ..	105·6	106·0	106·0	106·3	106·5	106·8	108·1	..	..
75 ..	105·6	106·3	106·7	106·1	106·7	107·4	108·0	[118·9] 3·7 (4)	..
65 ..	..	105·8	105·8	106·2	106·7	107·8	108·1	[112·2] 6 (1)	[118·9] 2·3 (4)
55 ..	..	..	106·1	106·5	106·8	108·0	107·6	[109·2] 6·7 (1)	[116·3] 2·1 (4)
45 ..	..	..	..	106·2	106·6	107·1	107·5	[110·2] 6·5 (1)	[113·9] 3·1 (4)
35 ..	..	..	..	..	..	107·1	107·7	[113·3] 3·1 (1)	[111·9] 5·5 (3)
25 ..	..	..	..	..	..	..	..	[111·2] 6·6 (1)	..

Rectal temperatures represent the average for the period of exposure in degrees F. Figures enclosed in brackets have been weighted for the time of exposure (*see text*). Small figures appearing below bracketed temperatures and to the left indicate the average time (in hours) the fowls remained in the room, those to the right indicate the number of fowls removed.

RECTAL TEMPERATURE.

General Behaviour.—In Fig. 1 is indicated the rise of rectal temperature that occurs in hot atmospheres which are just not sufficiently severe to cause collapse of any bird in seven hours exposure. The rise tends to be rapid at first and then declines to a more or less steady rate of rise the gradient of which depends upon many factors. In less trying atmospheres actual equilibrium is obtained. (Fig. 5.)

Relative Effects of Temperature and Humidity.—It is obvious that the four climatic factors of radiation, conduction, evaporation, and convection must all be included in a complete consideration of energy exchanges between an animal and its environment; they must all affect positively or negatively, its ability to keep body temperature constant. A more complete consideration will be undertaken at a later date. For the purpose of these experiments radiation was kept low, negative, and in known relationship to the conduction factor, while the convection factor was kept constant. In the "effective temperature"* series, however, different combinations of dry bulb temperature (radiation-conduction factor) and relative humidity (evaporation factor) were used. It is of practical importance to know when and to what extent humidity as well as temperature affects a bird's reactions.

In Table 2 the response of rectal temperature to different combinations of temperature and humidity is set out in the form of a grid for each of the two breeds studied. The figure appearing in a square of the grid represents the average temperature of all four birds of that breed in that atmosphere. In the more severe atmospheres birds frequently had to be removed before the seven hours had elapsed. In this case the average has been weighted, thus:—

> If a_0 is fowl's average temperature in the ante-room, a_1 the fowl's average temperature during its stay in the hot room, a_2 the desired weighted average, and t the duration of its stay in the hot room, then
>
> $$a_2 = a_0 + \frac{7}{t}(a_1 - a_0).$$
>
> This assumes a linear progress for the function in question, which, while not being accurate, provides a sufficient weighting for the somewhat gross comparative work here being attempted.

The weighted averages are enclosed in brackets on the grids.

Inspection of the grids shows the following points:—

(i.) Below a dry bulb temperature of 85 degrees F., neither temperature nor humidity produces much apparent effect upon the rectal temperature. There is some tendency for it to be lower over the lower ranges of both factors, but the figures are somewhat irregular.

(ii.) A dry bulb temperature of 85 degrees in all instances produces a higher average rectal temperature than one of 80 degrees in the Australorp, but only in some instances in the Leghorn. Humidity would seem to play no part here.

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* An explanation of the term "effective temperature" is not necessary to this paper, but it is employed here as it will appear in connection with further work now in hand.

TABLE 3.

EFFECT OF FREE AND FORCED WATER-FEEDING.

		Free.	Full Forced.	Half Forced.	Nil.
Av. Rect. Temp. °F.	Australorp ..	108·6	[115·0] 4 (4)	[111·5] 5·6 (3)	[112·2] 6·2 (2)
	White Leghorn	108·0	[116·5] 5·8 (1)	109·4	110·0
Av. Pulse Rate ..	Australorp ..	278	274	272	261
(Beats/min.)	White Leghorn	271	283	275	268
Av. Resp. Rate ..	Australorp ..	94	[224]	[136]	[144]
(Resp./min.)	White Leghorn	89	[384]	154	153
Av. Evap. Loss ..	Australorp ..	37	[47]	[23]	[28]
(Gms./hr.) ..	White Leghorn	45	[42·5]	22	25

Figures enclosed in square brackets have been weighted for the time of exposure (*see* text). Small figures appearing below bracketed temperatures and to the left indicate the average time (in hours) the fowls remained in the room, those to the right indicate the number of fowls removed.

TABLE 4.

EFFECT OF DIETARY PROTEIN LEVELS.

		5 Per cent.	11 Per cent.	17 Per cent.	22 Per cent.	28·5 Per cent.
Av. Rect. Temp. °F.	Australorp ..	108·9	[109·9] 6·6 (1)	108·6	[111·7] 5·3 (2)	[111·3] 5·8 (2)
	White Leghorn	107·7	108·5	108·0	108·1	108·5
Av. Pulse Rate/min.	Australorp ..	263	274	278	272	270
	White Leghorn	260	269	271	272	269
Av. Resp. Rate/min.	Australorp ..	85	[102]	94	[129]	[100]
	White Leghorn	62	112	89	125	100
Av. Evap. Loss .. (Gms./hr.)	Australorp ..	37	[44]	37	[41]	[43]
	White Leghorn	43	41	45	41	35

Figures enclosed in square brackets have been weighted for the time of exposure (*see* text). Small figures appearing below bracketed temperatures and to the left indicate the average time (in hours) the fowls remained in the room, those to the right indicate the number of fowls removed.

(iii.) At 90 degrees the average rectal temperature is definitely raised in all instances in both breeds, but more markedly in the Australorp. Humidity of 55 per cent. and below provides a saving for the Australorps which puts them on a level with the Leghorns, which do not gain anything from these reduced humidities.

(iv.) As the dry bulb temperature rises still higher, the effect upon rectal temperature becomes more and more pronounced, but again more markedly so in the Australorp. A sparing action of lower humidities shows up here, though in a somewhat irregular fashion, and on the whole this is more noticeable in the Australorps. It must be realized, of course, that even a relatively small benefit at these levels may save the life of the birds concerned.

(v.) At 100 degrees F. some Australorps had to be removed before the conclusion of the seven hours test period on the two most humid days (75 and 85 per cent.), but all Leghorns remained in. At temperatures of 105 degrees and over some or all of both breeds had to be withdrawn, even at the low humidities. The number of fowls withdrawn is shown in the bottom right-hand corner of the squares, and here again the Leghorn shows a lower casualty rate.

Effect of Hydration.—The importance of maintaining bodily water content within certain limits has been shown repeatedly for man. [2, 4] The position in the case of fowls was investigated by making the usual observations upon four different occasions. On the first trial free water-drinking from a vessel was permitted and the average rate of evaporation measured. On the second occasion, an amount of water approximately equal to the quantity of water so determined as being evaporated was injected from a syringe directly into the crop. On the third occasion, half this amount of water was given and on the fourth no water. (For amounts see above.)

In Table 3 appear the average rectal temperatures (calculated as above) for these trials. It will be seen that water administration directly into the crop does nothing to relieve the rise of rectal temperature, but that if free water-drinking is permitted, some relief is obtained. This raises the question as to what difference there is between water injection and free water-drinking. From general observations upon the fowl's behaviour it is tentatively concluded that with free water-drinking the immersion of the head provides a method of evaporation.

Effect of Dietary Protein.—It appears to be well established that for omnivorous and carnivorous mammals protein possesses a high specific dynamic action. For these animals, therefore, a high level of protein in the diet should prove an extra embarrassment when heat regulation is being severely strained by hot conditions. Direct evidence on this point for mammals is, at present, inadequate. In view of the frequent advocacy on other grounds of a high protein diet for fowls, it was determined to apply a direct test to our birds. The diets (details given p. 107) were similar in all respects except that the percentage of protein was varied and starch was added to the lowest diet. Birds were kept on any one diet for a week before the trial.

In Table 4 appear the average rectal temperatures (calculated as above) so obtained. It will be seen that while there was some intensification of heat effects with the very high protein diets the differences are not definitely significant. In the case of the Australorps, there was some tendency for collapse to occur earlier.

TABLE 5.

Variability of Ante-Room Values in Single Fowls.

	Bird No.	Rectal Temp. °F.			Pulse Rate /Min.			Resp. Rate /Min.			Days of Observation.
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	
Australorps.	1 ..	106·0	104·0	105·2	300	240	282	36	12	20	13
	3 ..	107·8	104·6	106·0	300	228	276	60	24	42	33
	4 ..	105·6	103·4	105·1	300	216	276	56	36	44	13
	5 ..	106·8	104·4	105·5	324	252	276	48	28	38	47
	11 ..	106·8	105·2	106·1	288	264	276	16	12	16	28
	12 ..	107·0	105·4	106·2	300	264	282	56	16	46	32
	50 ..	107·2	105·3	105·8	288	264	276	44	24	33	15
White Leghorns.	14 ..	107·5	105·0	106·0	300	192	276	72	36	51	47
	20 ..	107·3	105·0	106·0	300	252	276	72	28	52	47
	21 ..	106·6	104·0	106·0	288	228	276	80	32	50	47
	22 ..	106·7	104·4	105·7	288	252	276	84	56	68	47

TABLE 6.

Variability of Reactions in Different Fowls after 7 Hours at 95 Degrees F.

			Relative Humidity.					
			95 Per Cent.	85 Per Cent.	75 Per Cent.	65 Per Cent.	45 Per Cent.	35 Per Cent.
Rectal Temp. °F.	Australorps ..	Max.	112·3	108·7	109·5	111·4	109·0	108·0
		Min.	111·2	107·8	108·8	108·8	106·5	107·0
	White Leghorns	Max.	108·4	107·9	108·0	109·0	107·4	107·6
		Min.	107·7	106·8	107·4	107·0	106·9	107·4
Pulse Rate.	Australorps ..	Max.	324	276	300	288	300	276
		Min.	288	252	276	264	288	264
	White Leghorns	Max.	300	288	300	288	300	276
		Min.	276	252	264	264	264	252
Resp. Rate.	Australorps ..	Max.	88	52	68	80	72	52
		Min.	36	28	36	48	32	32
	White Leghorns	Max.	92	80	76	96	76	72
		Min.	40	36	36	48	36	32
Wt. loss gms/hr.	Australorps ..	Max.	10	14	17	16	24	35
		Min.	4	8	13	12	7	30
	White Leghorns	Max.	7	22	23	18	35	40
		Min.	4	8	13	13	14	25

Variations in Reaction.—Any one bird appears to behave in a fairly constant fashion as regards rectal temperature. In Table 5 appear the maximum, minimum, and average ante-room temperatures of those fowls observed over the longest periods.

Statistical treatment of the temperatures measured in the ante-room yields the following data:—

Breed.	No. of Birds.	No. of Meas.	Min.	Max.	Mean.	S.E. of Mean.	Stand. Dev.
Australorps ..	16	250	103·4	107·8	105·87	±·038	±·604
Leghorns	13	255	104·0	107·5	105·91	±·028	±·447

Variation between individuals is thus restricted, especially in the Leghorns. In Table 6 are given the maximum and minimum rectal temperatures prevailing in the fowls of the two breeds at the end of the trials at 95 degrees F. It will be seen that the absolute range of variation is smaller than in the ante-room.

In sharp distinction to the constancy of behaviour in any one individual, and the small degree of variation between different individuals of the same breed, the variation in reaction between the two breeds studied here is marked. Starting from the same mean rectal temperature in the ante-room the Australorps in all atmospheres above the lower critical level show a definitely greater rise of temperature than the Leghorns. This is reflected in the higher average temperatures shown in Tables 2, 3, 4, and 6 by the Australorps and the greater number of Australorps removed for collapse in atmospheres of 100 degrees and 105 degrees F. (Table 2). Possible explanations for this difference will be considered below. (Powers of Heat Regulation.)

PULSE RATE.

General Behaviour.—In marked contra-distinction to the rectal temperature, pulse rate shows no consistent change upon exposure to heat (Fig. 1). This is markedly different from the behaviour of the pulse rate in man[2, 4] and many mammals under similar circumstances.

Relative Effects of Temperature and Humidity.—In Table 7 are set out the average pulse rates of the fowls during their tenure of the hot room under different conditions. There is no apparent orientation in this grid. Indeed, considering the relative crudity of the counting method used, the degree of variation anywhere is slight.

Effect of Hydration.—In Table 3 appear the average pulse rates of the fowls enjoying different degrees of water replacement. This apparently had no constant effect upon the pulse rate.

Effect of Dietary Protein.—Table 4 contains the average pulse rates of the same fowls stabilized upon different levels of dietary protein. Again there is no detectable influence of this factor.

Variations.—In Table 5 are set out the maximum, minimum, and average ante-room pulse rates of the fowl studied over the longest periods. The degree of variation in the one individual—taking into account the method of counting used—is not great.

TABLE 7.

TEMPERATURE-HUMIDITY GRIDS IN RESPECT OF PULSE RATE.

Australorp.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	280	277	283	271	276	298	..	..	..
85 ..	272	277	271	275	272	270	276	..	..
75 ..	266	274	263	275	277	284	272	270	..
65 ..	..	277	289	270	271	276	275	271	271
55 ..	..	..	269	270	281	275	284	266	295
45 ..	..	..	..	284	278	288	276	276	290
35 ..	..	..	..	..	..	263	282	288	283
25 ..	..	..	..	..	..	..	..	299	..

White Leghorn.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	282	275	281	281	281	288	..	..	..
85 ..	270	272	270	274	266	274	271	..	..
75 ..	274	272	268	276	277	281	276	312	..
65 ..	..	280	288	276	275	280	281	272	271
55 ..	..	..	262	275	282	281	280	282	299
45 ..	..	..	..	288	278	274	277	280	278
35 ..	..	..	..	..	..	259	281	280	277
25 ..	..	..	..	..	..	..	..	295	..

Pulse rates represent the average for the period of exposure.

The extremes of variations of pulse rate between individuals is more marked than that of rectal temperature, as is shown by the following statistical data:—

Breed.	No. of Birds.	No. of Meas.	Min.	Max.	Mean.	S.E. of Mean.	Stand. Dev.
Australorps ..	16	251	204	324	278·0	±0·8	±12·6
Leghorns	13	254	192	312	275·2	±0·8	±12·7

In Table 6 are given the maximum and minimum pulse rates prevailing in the fowls of the two breeds at the end of the trials at 95 degrees F. The variation here is again less than in the ante-room.

The difference between the means of the ante-room pulse rates of the two breeds is statistically just significant, but in view of the method of measurement, this should probably be discounted. No more significant breed difference was detected in the hot room.

Correlation with Body Temperature.—That there is no correlation of pulse rate and body temperature in the fowls studied is seen by comparing the grids of Tables 2 and 7. The significance of this will be considered later. (Powers of Heat Regulation.)

RESPIRATORY FUNCTIONS.

General Behaviour.—In Fig. 2 appears a typical curve of the response of respiratory rate under hot conditions. The rate rises somewhat irregularly, but at a fairly uniform general rate throughout exposure to these trying conditions. The type of breathing was seen to alter from faster but normal respirations, through rapid panting to sighing action with the onset of collapse.

Relative Effects of Temperature and Humidity.—In Table 8 is given a temperature-humidity grid in respect of respiratory rate for each of the two breeds studied. The figures represent averages calculated as in the case of rectal temperatures above. Inspection of the grids reveals the following points:—

(i.) Below a dry bulb temperature of 90 degrees F., neither temperature nor humidity produces much effect upon the respiratory rate.

(ii.) A dry bulb temperature of 90 degrees in most instances produced a higher respiratory rate than one of 85 degrees, particularly in the Australorps.

(iii.) At 95 degrees the average respiratory rate is raised in all instances but one in both breeds. There is practically no tendency at this level for low humidities to effect a sparing action.

(iv.) As the dry bulb temperature rises higher the respiratory rate increases rapidly, especially at the higher humidities. The rapid rise associated with conditions which produce collapse is reflected in the high values of the weighted averages in these instances. There is some irregularity in the relative sparing effects of medium and low humidities. This matter will arise again in the following section. (Evaporation of Water.)

Effect of Hydration.—In Table 3 appear the average respiratory rates for fowls kept at the different hydration levels. It will be seen

TABLE 8.

Temperature-Humidity Grids in Respect of Respiratory Rate.

Australorp.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	32	36	36	36	41	64	..	..	..
85 ..	34	34	36	36	37	44	[128]	..	..
75 ..	38	34	39	37	43	44	[112]	[252]	..
65 ..	..	31	33	37	46	50	68	[170]	[262]
55 ..	..	..	34	36	38	40	50	[174]	[281]
45 ..	..	..	..	33	32	50	74	[124]	[171]
35 ..	..	..	..	..	..	40	74	[171]	[73]
25 ..	..	..	..	..	..	..	..	[60]	..

White Leghorn.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F								
	70	75	80	85	90	95	100	105	110
95 ..	55	54	56	44	55	66	..	..	..
85 ..	60	57	58	54	50	62	74	..	..
75 ..	47	52	55	51	63	56	73	[308]	..
65 ..	..	48	54	53	59	72	76	[153]	[308]
55 ..	..	..	46	60	55	60	69	[100]	[200]
45 ..	..	..	..	50	49	54	74	[129]	[246]
35 ..	..	..	..	..	..	51	69	[164]	[127]
25 ..	..	..	..	..	..	..	..	[148]	..

Respiratory rates represent the average for the period of exposure, expressed as respirations per minute. Figures enclosed in brackets have been weighted for the time of exposure (*see* text).

that, as in the case of body temperature, forced water-feeding afforded no relief to the respiratory rate, whereas with free water-drinking definite relief was obtained.

Effect of Dietary Protein.—Table 4 includes average respiratory rates for fowls kept on different protein levels. There is some suggestion of a reduced rate with the lowest protein ration, but no regular variation with successive increases of protein above 11 per cent.

VARIATIONS IN REACTION.

Statistical treatment of the respiratory rates measured in the ante-room yields the following data:—

Breed.	No. of Birds.	No. of Meas.	Min.	Max.	Mean.	S.E. of Mean.	Stand. Dev.
Australorps ..	16	250	12	76	35·7	±0·7	±11·1
Leghorns	13	256	20	84	44·4	±0·8	±12·5

The wide range of variation in a single individual is somewhat, but not much, increased when groups of individuals are considered.

This rather wide variation of and between individuals in temperate atmospheres is not lessened upon exposure to heat. In Table 6 are given the maximum and minimum respiratory rates prevailing in the fowls of the two breeds at the end of the trials at 95 degrees F.

The difference between the two breeds is quite marked. The difference in the means of the ante-room counts is quite significant. This difference, while persisting at intermediate temperatures, tends to disappear or even to become reversed at higher temperatures. (Fig. 2, Table 8.)

Correlation with Body Temperature.—Comparison of the temperature-humidity grids in respect of rectal temperature and respiratory rate (Tables 2 and 8) indicates a high degree of correlation, particularly if allowance is made for the irregular nature of respirations associated with the highest temperatures. A correlation of type of respiration with rectal temperature was also observed. At a rectal temperature of about 108 degrees F. nasal breathing changed to panting, at a somewhat higher temperature (109 degrees F.) the rate rapidly increased, and as the critical temperature of 113 degrees was reached the respirations changed rather suddenly to slower deep sighs or even gasps. (These changes are to be seen better in curves for individual fowls than in the average graphs of Figs. 1 and 2.) It should be noted that the critical temperature for respiration rise lies higher than that for rectal temperature rise and that in any one bird the respiratory rate does not increase until the rectal temperature has already risen.

EVAPORATION OF WATER.

General Behaviour.—Evaporative loss tends to be low during exposure to intermediate temperatures and the early stages of exposure to high temperatures. In the latter case, however, it changes rather suddenly to a much higher rate which persists more or less unchanged during the rest of the trial. This change coincides roughly with the onset of panting. (Fig. 2.)

TABLE 9.

TEMPERATURE-HUMIDITY GRIDS IN RESPECT OF EVAPORATIVE LOSS.

Australorp.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	−1·5	−2·5	−3·5	−1·5	4	3	..	..	..
85 ..	3·5	1·5	2·5	−0·5	1	4·5	[10]	..	..
75 ..	3·5	3·5	5	6	6	8·5	[12]	[34]	..
65 ..	..	4·5	3·5	6	9·5	8·5	15·5	[30]	*
55 ..	..	..	4	8	9	14·5	21	[22]	[49·5]
45 ..	..	..	..	8	10	10	19	[36]	[33]
35 ..	..	..	..	..	..	11·5	14·5	[36·5]	[26]
25 ..	..	..	..	..	..	..	..	[30]	..

White Leghorn.

Rel. Hum. Per Cent.	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	−1	−2·5	−3·5	−1·5	4·5	3·5	..	..	..
85 ..	4·5	−1·5	4	4	1·5	7	12	..	..
75 ..	4	4	4·5	8	8·5	10·5	17	[32]	..
65 ..	..	4·5	6·5	6	9·5	11	22·5	[29]	*
55 ..	..	..	7·5	11·5	14	18	26·5	[35·5]	[53]
45 ..	..	..	..	13	12·5	15	26	[38·5]	[38·5]
35 ..	..	..	..	..	..	13	15·5	[27·5]	[39]
25 ..	..	..	..	..	..	..	..	[37]	..

* Not in hot atmosphere long enough to determine loss.

Evaporative losses represent the average for the period of exposure in grams per hour. Figures enclosed in brackets have been weighted for the time of exposure (*see* text).

Relative Effects of Temperature and Humidity.—It is a fair assumption under the conditions of the experiments that the loss of weight by the cage containing both the bird and its water tin, less a correction for evaporation from the tin directly, represents evaporation of water from the bird. Before this can be identified, however, with insensible evaporation in its physiological sense, an allowance has to be made for water exchange between the atmosphere and the feathers and cage. The extent of the corrections required for this are being determined.

In Table 9 appear the temperature-humidity grids for average net weight loss per hour. Inspection of these grids shows that the rate of evaporation increases markedly with rise of temperature. The figures in the lower ranges of temperature would probably conform also if allowance were made as just indicated for changes in feather water content. With decreasing humidity the rate of evaporation generally increases, particularly through the upper ranges.

Effect of Hydration.—The average rates of evaporation per hour (calculated as described above under Rectal Temperature) shown by the fowls with different degrees and methods of hydration are included in Table 3. Fowls allowed free water-drinking show greater evaporative loss than fowls deprived of water or forcibly fed with half replacement amounts. Leghorns show a greater loss than Australorps when allowed free drinking, but not otherwise. The significance of these observations will be discussed below.

Effect of Dietary Protein.—As with other reactions, the level of dietary protein appeared to be without effect upon evaporative loss. (Table 4.)

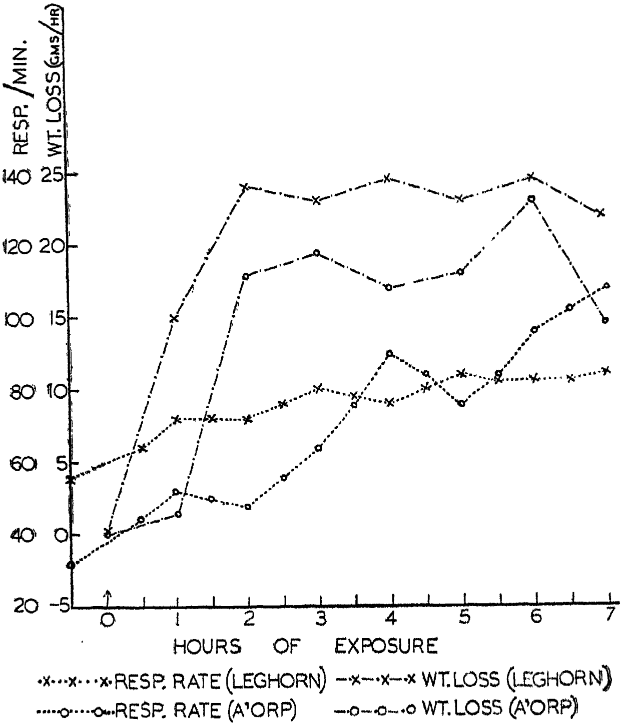
Variations in Reaction.—In Table 6 are given the maximum and minimum rates of evaporative loss exhibited by the fowls of the two breeds at the end of the trials at 95 degrees F. The variability is fairly great.

Comparison of the temperature-humidity grids for the two breeds (Table 9) indicates a generally greater rate of evaporative loss from the Leghorns at intermediate temperatures. This superiority is lost when water is given directly into the crop. (Table 3.)

Correlation with Respiration.—If the temperature-humidity grid in respect of respiratory rate (Table 8) is compared with that in respect of evaporative loss (Table 9), some interesting features are seen. There is a general correlation as regards dry bulb temperature, both respiratory rate and evaporation rising markedly with increased temperature, but this correlation is not seen as regards humidity. While the respiratory rate in many instances tends to fall with decreasing humidity, the evaporative loss tends to rise or remain steady. This is, of course, explicable when it is remembered that evaporative loss from the lungs depends upon two factors—the rate of pulmonary ventilation and the humidity of the inspired air—factors which, in this case, move in opposite directions. The sharp rise of evaporative loss in the course of the hotter trials (Fig. 2) was seen to be associated with a change of respiratory type from the normal to panting.

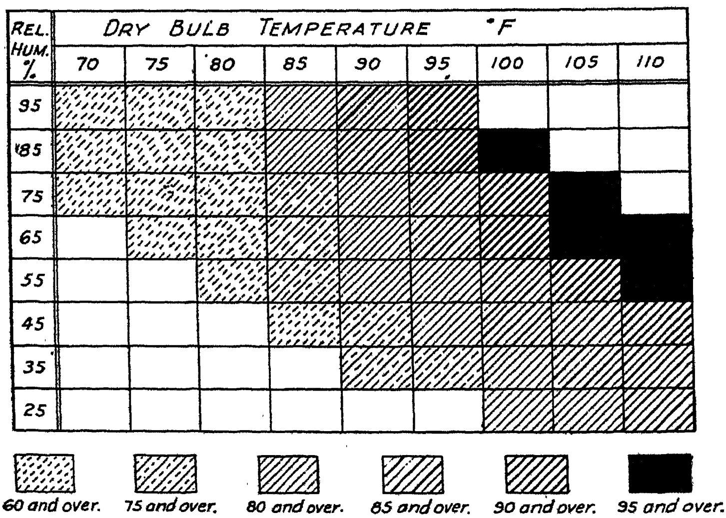
POWERS OF HEAT REGULATION.

Comparable Atmospheric Conditions.—In Fig. 4A.-D. the results of Tables 2 and 8 are expressed in graphic form, to permit a general



TEXT FIGURE 2.

Reactions of Respiratory Rate and Rate of Weight Loss of Fowls exposed to 100° F., with 65 per cent. Relative Humidity.



TEXT FIGURE 2.

Diagram to show relative importance of temperature and humidity upon the general reactions of man. (Compiled from the nomogram for effective temperature, designed by the American Society of Heating and Ventilating Engineers.)

analysis of the relative effects of dry bulb temperature and humidity upon the rectal temperature and respiratory rate. It will be seen from this that the dry bulb temperature is the all-important factor determining the behaviour of the hen in these two respects. Humidity is not entirely without effect however. The lowest humidities seem to exert some sparing action at all temperatures, whilst the highest humidities have an enhanced influence at the higher temperatures. The influence of humidity seems to be rather more apparent in the Australorp than the Leghorn. The influence of humidity is, however, not nearly as marked as in man. (Fig. 3.)[5]

Critical Temperatures.—A shade dry bulb temperature of 80-85 degrees F. for an Australorp, and of 85-90 degrees F. for a White Leghorn, marks the upper limit at which these hens can maintain their equilibrium undisturbed for seven hours.

A rectal temperature of about 108 degrees F. is accompanied by a change to open-mouthed panting, and one of about 109 degrees F. by a sudden increase in rate. These two factors together are accompanied by a marked rise in the rate of water evaporation.

A rectal temperature of 113 degrees F. marks the limit of continued existence as an integrated organism. Deep sighing or gasping respirations, weakness of the legs, collapse and loss of consciousness follow in rapid succession, and if relief is not rapidly given death ensues.

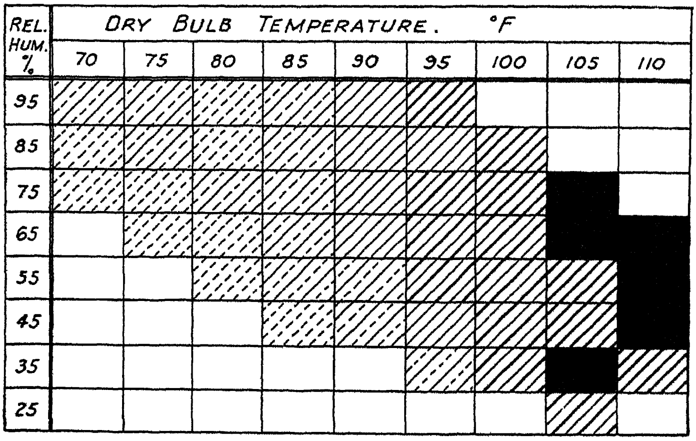
No hens have succeeded in remaining for seven hours at a dry bulb temperature of 105 degrees F. with a relative humidity of 75 per cent., or at 110 degrees F. with a relative humidity of 45 per cent. or over.

Methods of Heat Regulation.—Heat loss by radiation and conduction from the general surface of the hen's body must at all times be severely limited by the depth of the "private atmosphere" provided by the covering of large non-vascular feathers. This protection against heat loss is somewhat reduced under conditions of stress by the stance of the bird with the wings held out from the body. This position at the same time increases the "effective radiating surface" and exposes the less densely feathered portions of the body.

Of the non-feathered parts, the legs have a relatively large, but horny, non-vascular surface, and probably afford but little relief. The wattles and comb, on the other hand, have a very rich vascular supply with a thin skin. Radiation and conduction exchanges from these may very well be of great importance. It is highly probable that the superiority of the Leghorn over the Australorp is due in large part to its larger head appendages. (Plate IV*c*) This would be in conformity with Hutt's observations upon Rhode Island Reds and Barred Rocks.[3]

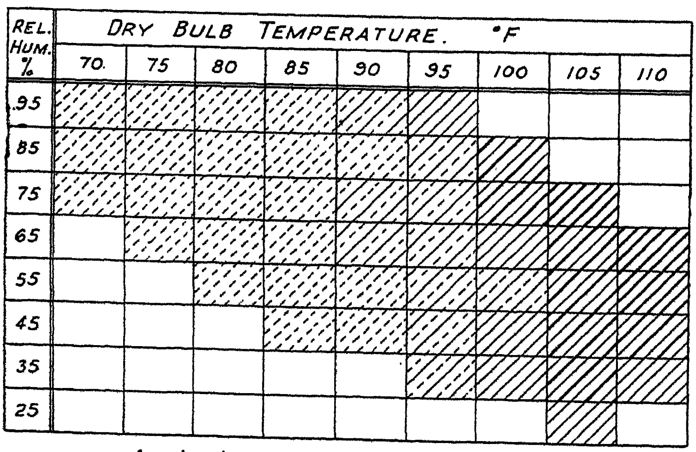
The remaining method of heat loss available to animals is that of evaporation. This may occur in four ways—evaporation from lungs and air passages, evaporation from surface moisture transuded through the integument, evaporation of moisture supplied by sweat glands, and evaporation of moisture obtained from external sources. The third of these can be dismissed as the hen possesses no sweat glands.[1] The second is probably severely restricted by the dense feathery covering, although this point will be subjected to verification at a later date. The two remaining methods are of relatively great importance to the fowl.

The fowl, unlike the dog, has a relatively small area of buccal mucous membrane, and much of the tongue is horny, while the nasal

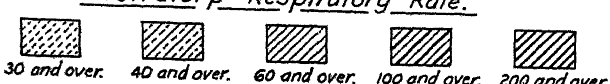


Australorp- Rectal Temp.

TEXT FIGURE 4A.

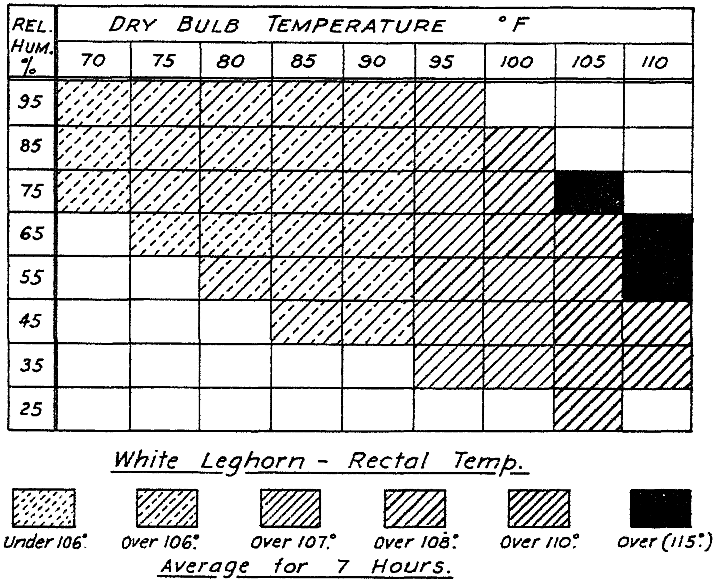


Australorp- Respiratory Rate.

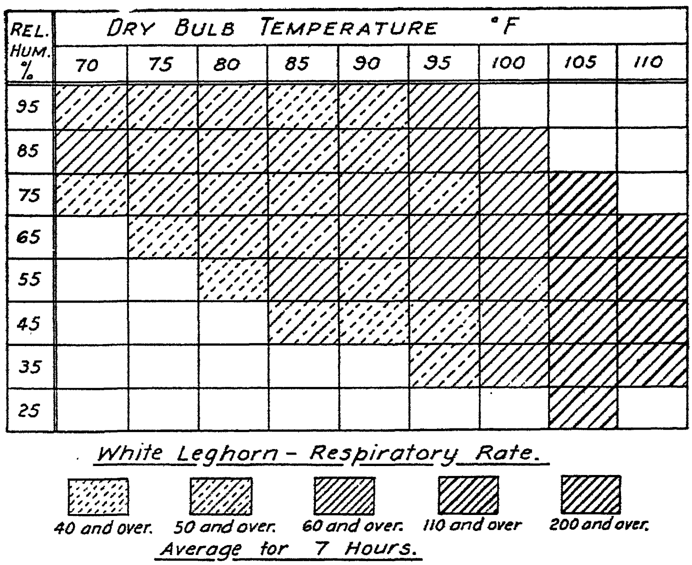


Average for 7 Hours.

TEXT FIGURE 4B.

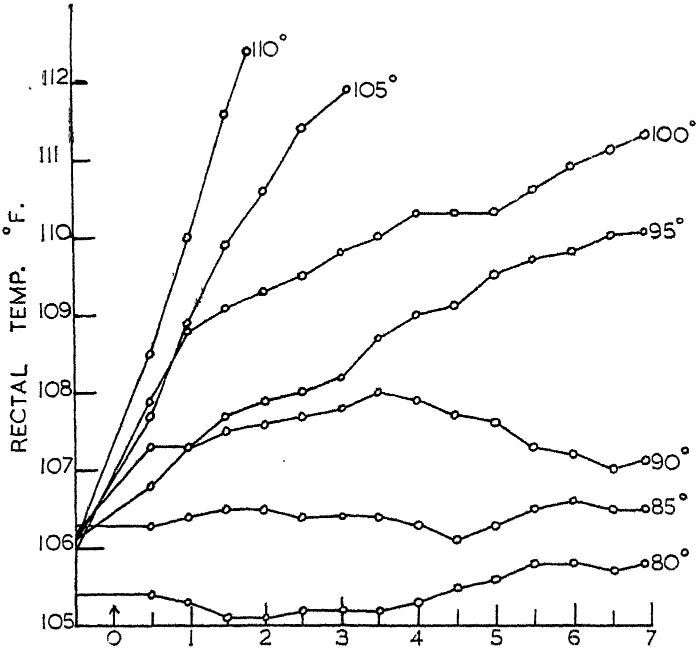


TEXT FIGURE 4C.

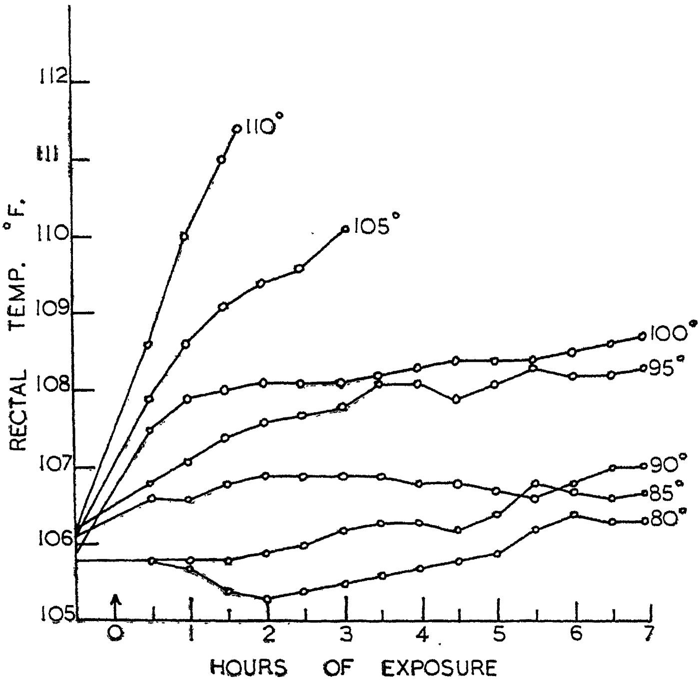


TEXT FIGURE 4D.

Diagram to show relative importance of temperature and humidity upon the reactions of the fowl.



AUSTRALORPS



WHITE LEGHORNS

Room Temp. is shown within the Graphs.

TEXT FIGURE 5.

Behaviour of the Rectal Temperature of Fowls exposed to Atmospheres of Different Temperatures (each at 65 per cent. Relative Humidity).

passages are small, so that evaporation from the upper respiratory passages is limited. Hence, true tachypnoeic respiration, in which the dead space air is pushed back and forth over moist non-pulmonary membranes, could be of little avail in increasing heat loss. Nevertheless, the fowl does use accelerated breathing as a method of increasing evaporation, as is obvious from Figs. 2 and 6 and Tables 8 and 9, and this use is closely correlated with the fowl's body temperature. This evaporation must occur from the deep pulmonary epithelium, and must call for marked tolerance or powers of regulation of the acid-base balance. Comparative studies of this mechanism are being made. It is not known to what extent the air-sinuses of the bones aid in this process. Part of the superiority in heat regulation of the Leghorn over the Australorp may be due to its higher respiratory rate.

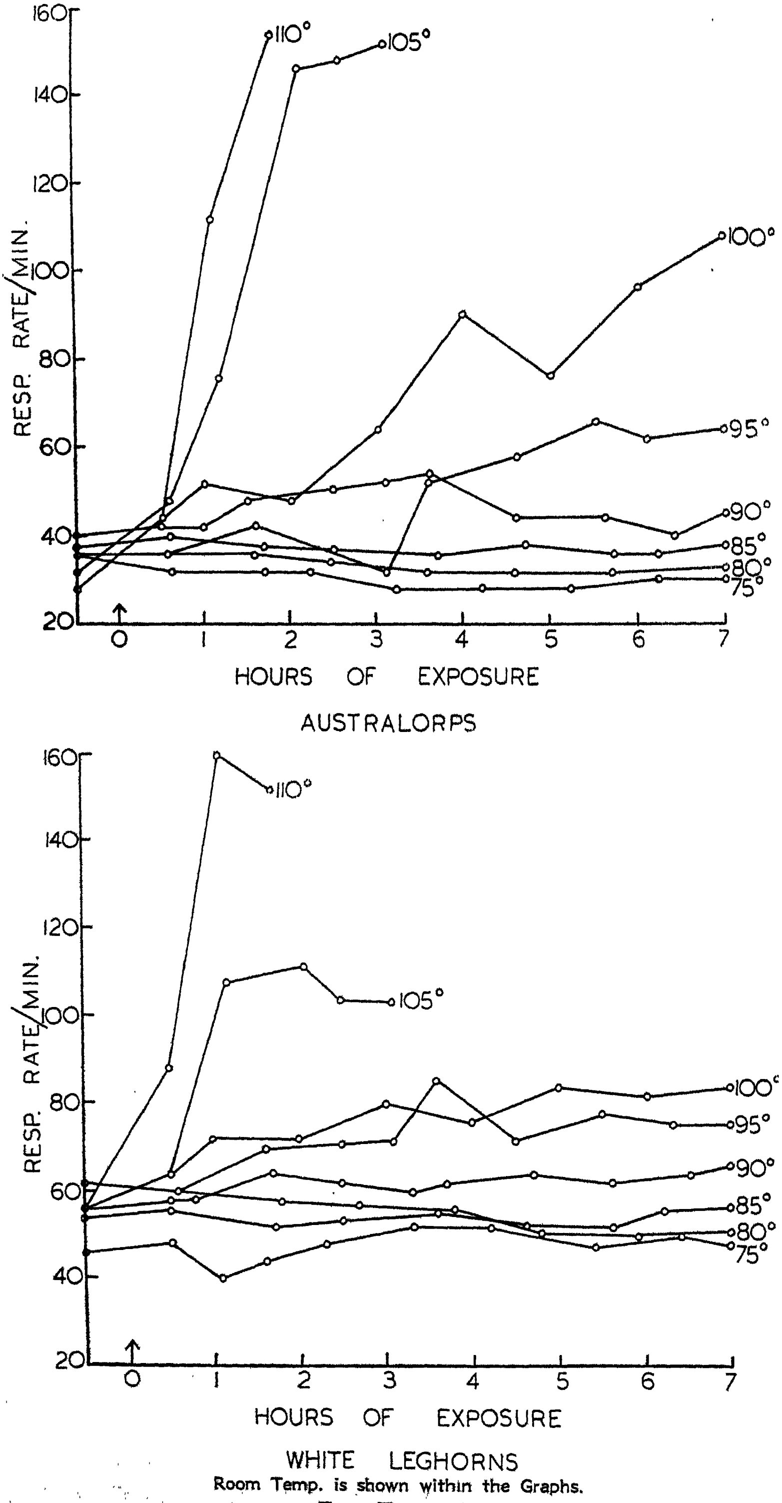
The superiority of fowls permitted free water-drinking over those fed water direct into the crop draws attention to the method of drinking. In our experiments open tins were provided and the fowls definitely took advantage of this to dip the head into the water. The head is thus cooled, mainly by evaporation of water. The anterior portions of the Leghorn's comb were quite cold to the touch, when the posterior portions not dipped into water were burning. The rich vascular supply to these appendages gives every opportunity for a rapid distribution of this cooling effect over the body. The Leghorns appeared to take special advantage of this, and their rate of evaporation is greater when allowed free water-drinking, but the comparative figures (Table 3) do not show that they added any more to their constitutional superiority thereby.

A striking feature of the fowl's struggle against high environmental temperature is the absence of any response by the heart rate. This may merely indicate that special demands are not made upon the cardiovascular system, in which case the fowl differs markedly from many mammals, or that there is very little reserve power available to the fowl to increase its heart rate. This matter also is receiving further attention.

The part played by such factors as colour, body form, and superficial fat have not been specially studied, so that no opinion will be ventured at this stage.

Effects of Heat.—The first effect of heat is upon behaviour. Fowls pant and stand with wings partly outstretched, and are generally disinclined to exert themselves. The most dramatic effects are those which come on when the body temperature reaches 113 degrees F. Marked distress as shown by deep sighing respirations and shaky gait is followed by inability to stand, complete collapse with pale comb and outstretched legs, and death in rapid succession. This almost certainly corresponds to true heat-stroke in man, and represents failure of the central nervous system. The staggering gait seen in the earlier stages of decline and persisting for some time after resuscitation is probably due to failure of the striato-rubral mechanism.

If a laying hen is exposed without other disturbances to a hot atmosphere, it goes into a state resembling a partial moult. Laying is greatly reduced to about once a week, and some loss of small feathers occurs. Inasmuch as the metabolic rate is reduced thereby, this may be a rapid form of acclimatization. If exposure is frequently repeated the laying becomes a little more frequent but does not (in the course of four months) return to normal. Eggs laid during exposure are often



Room Temp. is shown within the Graphs.

TEXT FIGURE 6.

Reaction of the Respiratory Rate of the Fowl to Hot Atmospheres of Different Temperatures, but the same Relative Humidity (65 per cent.).

soft-shelled and misshapen, and the actual act of laying the egg has a pronounced effect upon the body temperature, sometimes raising it by 2 degrees F. This may, of course, just serve to bring on heat-stroke in a bird which would otherwise escape. If exposure is not repeated, the partial moult soon passes off.

It is our impression that birds exposed to hot atmospheres contract respiratory and alimentary infections rather readily, but the changes of climate experienced by our birds were somewhat trying and do not afford a fair test.

PRACTICAL APPLICATIONS.

Limiting Atmospheric Conditions.—A dry bulb temperature of 80 degrees F. is the highest that hens of the two breeds used here can uniformly tolerate without showing disturbances of temperature and respiration. A dry bulb temperature of 100 degrees F. cannot be safely withstood for seven hours unless the humidity is below 75 per cent. A dry bulb temperature of 105 degrees F. can be safely withstood for only a few hours. As the temperature mounts higher, the tolerance time falls off rapidly. (Fig. 5.)

Water Supply.—A good water supply must be readily accessible to birds without undue movement and in wide-mouthed containers which permit the head to be dipped into the water. It is relatively more important that fowls should be able to wet their heads than that they should drink. Up to one pint per bird per day must be provided on hot days.

Protein Level in the Diet.—The level of protein in the diet is apparently immaterial.

Acclimatisation.—There should be less risk of death amongst laying hens during the later days of a heat wave, provided that the nights afford some relief, since laying is reduced and panic is less evident, but the egg production will be correspondingly reduced. It is possible that fowls resident for some time in hot climates develop a further acclimatisation.

Recognition and Treatment of Heat Effects.—Panting and wing holding are early indications that birds are feeling the heat. Some birds "sulk" in the corners, especially amongst the Australorps. In these the early warnings of impending heat-stroke are less easily recognised, so that they call for greater supervision. In the standing bird weakness of the legs, or staggering gait, calls for urgent attention. Deep or irregular sighing respiration is a serious sign. Complete collapse is self-evident but allows practically no time for treatment. Rectal temperature, if this can be secured, is a reliable guide; 113 degrees F. is the uppermost limit of safety.

We have found simple immersion in cold water a very effective means of resuscitation, especially if the bird can be placed in a cooler place. On a hot day, when the water itself is warm, it is evaporation that cools the bird and there is little risk of chilling effects, so that birds can be safely put in a shady dry and breezy place to dry. Treatment must be instituted, of course, before structural damage has been done to the central nervous system.

Selection of Type.—These experiments definitely show the superiority of the White Leghorn over the Australorp in combating high temperatures. Various causes have been suggested for this superiority.[3]

Of these, we feel that the larger combs and wattles and a higher respiratory rate are very important. This question is being further studied in relation to other breeds.

ACKNOWLEDGEMENTS.

The investigations here reported were carried out under the Commonwealth Research Projects Scheme for Universities, financed by the Commonwealth Government, through the Council for Scientific and Industrial Research. One of the authors (N. T. M. Yeates) was at the same time working as the Robert Philp Scholar in the University of Queensland. Valuable assistance and advice were received from officers of the University Department of Veterinary Science, the State Department of Agriculture and Stock, the Poultry Farmers Co-operative Society, and the National Utility Poultry Breeders' Association. The Commonwealth Meteorological Bureau kindly furnished weather data.

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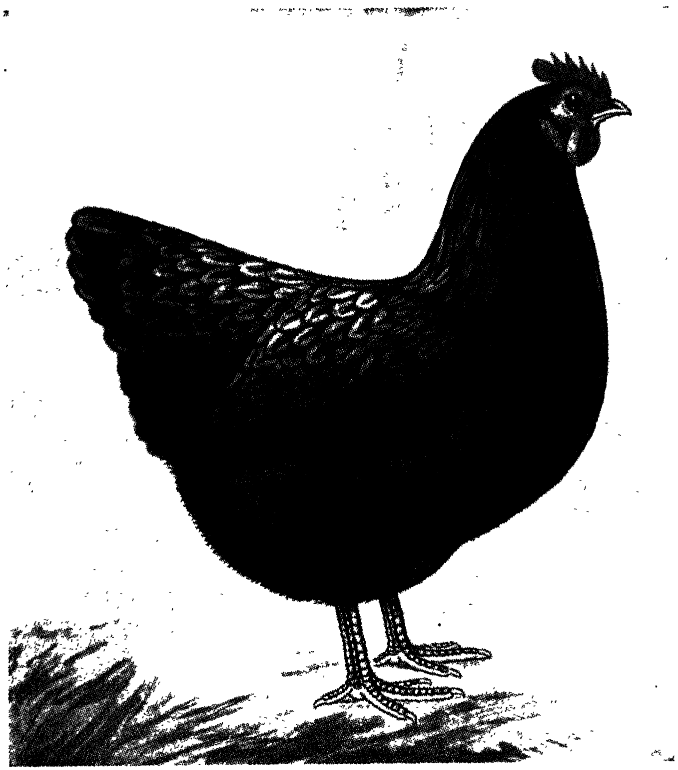
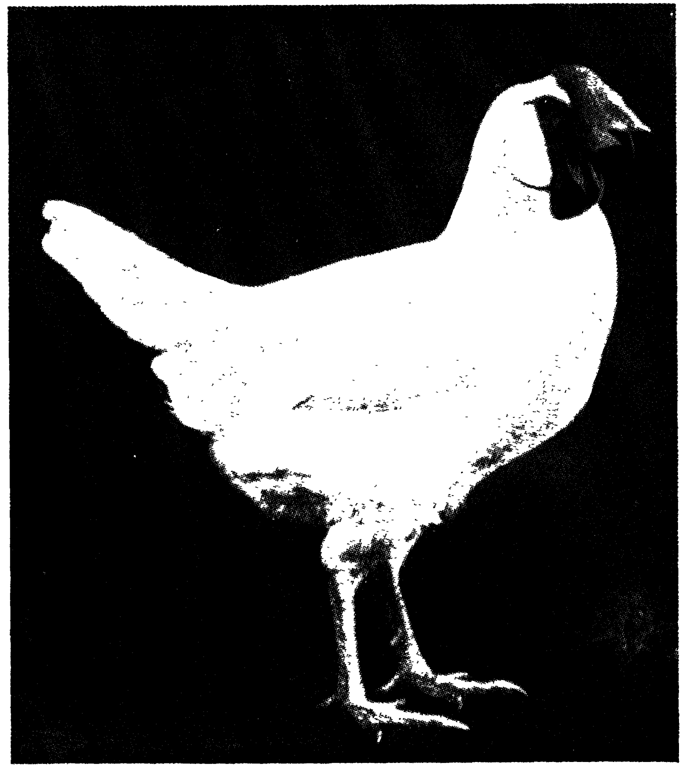


Australorp.



White Leghorn.

Body Form and Head Characters of Australorp and White Leghorn Hens.

[The Australorp is from a photograph authorised by the N.U.P.B.A. (Queensland).
[The White Leghorn is from a photograph in "Poultry Breeding and Production," by Edward Brown.

REACTIONS OF THE RABBIT TO HOT ATMOSPHERES.

By Douglas H. K. Lee, M.Sc., M.D., D.T.M., Kathleen Robinson, M.Sc., and H. J. G. Hines, B.Sc., Department of Physiology, University of Queensland.

(Six Text Figures.)

(*Read before the Royal Society of Queensland, 30th June, 1941.*)

INTRODUCTION.

Observations made upon domestic fowls when they are exposed to hot atmospheres have already been reported [Yeates, Lee and Hines (1941)]. Many mammals have been subjected to similar experimental enquiries, and the results obtained will be published in due course. Amongst these animals is the rabbit, which has been included in order to give a comparative basis to the series, a basis necessary to an adequate study of heat regulation in mammals. To these animal experiments must be added for this purpose, experiments previously made upon man. [Gregory & Lee (1936) Lee (1940) Lee and Boissard (1940) Lee, Murray, Simmonds and Atherton (1941).] If an additional reason is required for studying the animal, it should be realized that the limitation of the rabbit pest in Australia may well be bound up with biological limiting factors rather than artificial restrictions.

The experiments described here were designed to establish three things:—

(i.) The atmospheric conditions which produce heat-effects in rabbits;

(ii.) The importance of a drinking water supply;

(iii.) The effect of season and acclimatisation upon the rabbit's reaction.

While more animals, more breeds and further variations in conditions are being examined, it is considered desirable to make a preliminary report at this stage.

EXPERIMENTAL CONDITIONS AND METHODS.

Two male white angora rabbits were used. They were kept under normal atmospheric conditions when not required. On the day of the experiment the animal was placed in a cage measuring 9 inches high x 18 inches x 12 inches, with a ½-inch pine board on the floor, and introduced at 9.0 a.m. into the air-conditioning room, in which the required dry and wet bulb temperatures had been produced. It was kept in this room for seven hours unless removed earlier because the rectal temperature had reached 107 degrees F. and heat-stroke was imminent. Three series of experiments were conducted:—

(i.) Acclimatisation series.—After preliminary training at normal daily temperatures in January, the rabbit was introduced daily to a hot wet climate (dry bulb temperature 88 degrees F., wet bulb 85 degrees F.) six days a week for four weeks.

After four weeks at normal temperatures (March) the experiment was repeated in a hot dry climate (dry bulb temperature 106 degrees F., wet bulb 80 degrees F.). In June the experiment was repeated for two weeks with the hot wet climate. Observations were made five times a week during the first two weeks and at a week's interval thereafter.

(ii.) Effective temperature series.—Various combinations of dry bulb temperature from 70 to 110 degrees F. and of relative humidity from 25 to 95 per cent. were used on different days to ascertain the comparative action of these two atmospheric variables upon a rabbit's reactions.

(iii.) Hydration series.—On different days a rabbit was supplied respectively with no water, 8 ccs. of water hourly and 16 ccs. hourly, during exposure to an atmosphere with a dry-bulb temperature of 106 degrees F. and a wet-bulb temperature of 80 degrees F.

The rabbits were kept upon a diet of chaff with greens three times a week with pumpkins replacing the greens on the remaining days. Free water drinking was at all times permitted except in the case of animals during exposure in the hydration and acclimatisation series.

The following observations were made in an ante-room under normal atmospheric conditions before commencing each experiment and at suitable intervals in the hot room thereafter:—pulse rate, counted over 15-second periods by feeling over the femoral artery, rectal temperature by a clinical thermometer held in position, weight loss, measured by a Sauter balance sensitive to 0·5 gm., and general behaviour. In addition, respiratory rate and volume were measured. For this purpose a metal conical mask with a padded base moulded to the animal's face, was held firmly over the snout. The mask was fitted with inspiratory and expiratory butterfly valves in such a way as to reduce dead space to a minimum. The outlet was connected to a spirometer of low resistance and a side connection led to a tambour which wrote on a revolving drum. In this way the volume of expired air per minute and the respiratory rate could be determined simultaneously. Both rabbits were trained to this procedure for some days before being used for observation.

With the exception of the acclimatisation series, the experiments here described were carried out in the four months from winter to spring (July-October), and experiments were so spaced that little chance was given the animals to build up a long-term acclimatisation. The different experiments of the effective temperature series were well scattered over this period.

In all experiments the walls of the room were at the same temperature as the air, so that no new radiation factor was introduced, and the air-movement remained constant at an average velocity of 75 feet/min.

RECTAL TEMPERATURE.

General Behaviour.—In Text Fig. 1 is shown the temperature curve of a rabbit exposed to a temperature of 95 degrees F. at 75 per cent. humidity. It will be seen that the temperature rises rapidly at first, then more slowly until some kind of an equilibrium is obtained.

At less trying temperatures, equilibrium is obtained earlier, and at a lower level and is more stable. With higher temperatures, equilibrium later breaks down or is never attained. (Text Fig. 2.)

Relative Effects of Temperature and Humidity.—While it is generally recognised that the higher the temperature, the greater the disturbance of function, it is a matter of considerable argument what effect humidity has upon these reactions. The truth is, of course, that it varies with different animals and different temperatures. In order to present a systematic picture of the relative effects of these two atmospheric variables, a series of temperature-humidity grids have been prepared. In Table 1 is given the grid in respect of rectal temperature. The figure appearing in the square of a grid represents the average temperature of the rabbit during seven hours' exposure to those conditions. In more severe atmospheres the rabbit had to be removed before the seven hours had elapsed. In such cases the average has been weighted as described for the fowl [Yeates, Lee & Hines (1941)]. The weighted averages are enclosed in brackets on the grid.

TABLE 1.

RECTAL TEMPERATURE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	101·2	101·6	101·5	102·2	103·7	104·9			
85 ..	102·3	101·8	103·2	103·0	104·2	104·5	[111·2] 2·0		
75 ..	102·3	101·6	102·5	102·5	104·5	104·3	[107·6] 3·7	[114·7] 1·5	
65 ..		101·9	103·0	103·6	104·0	[107·9] 4·5	[106·2] 5·3	[110·2] 2·3	[114·5] 1·4
55 ..			102·4	103·0	103·6	105·8	[105·7] 6·0	[108·4] 3·3	[115·8] 1·3
45 ..				102·8	104·6	105·2	[106·0] 6·5	[106·9] 3·5	[111·2] 2·0
35 ..						104·6	104·9	[111·1] 2·5	[106·0] 2·0
25 ..								[105·6] 4·2	[105·6] 4·2

The figures in each square represent the average rectal temperature in degrees F. during the time the rabbit was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before seven hours had elapsed. The number below the bracket indicates the hours that the animal remained in the room.

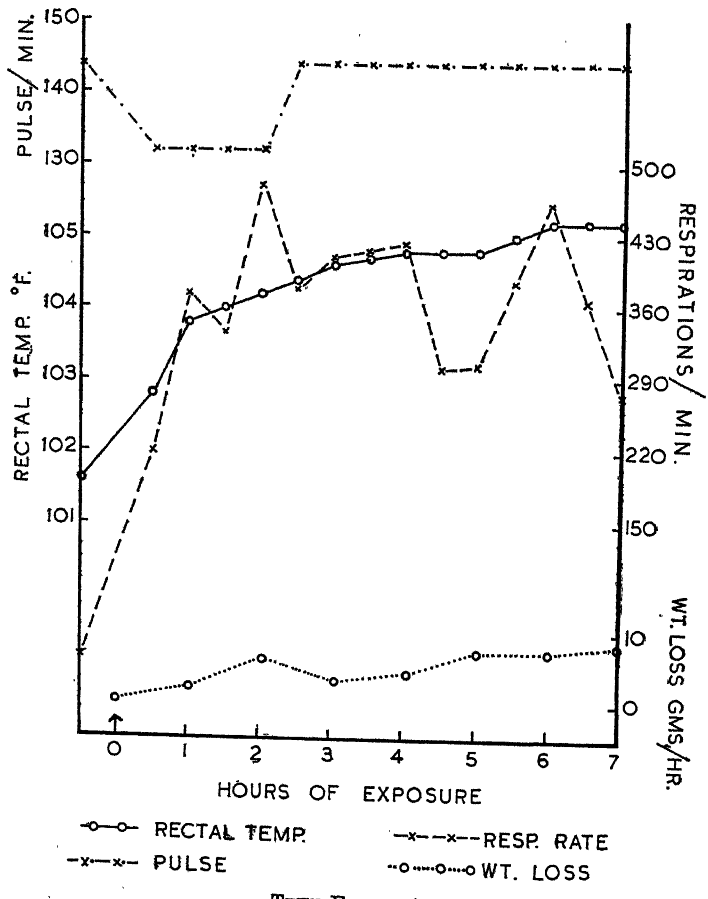
Inspection of the grid shows the following points:—

(i.) Below a dry bulb temperature of 85 degrees F., neither temperature nor humidity produces any regular effect upon the rectal temperature. In some instances a temperature of 80 degrees F. was accompanied by a rectal temperature in the upper ranges of the normal distribution (see below).

(ii.) With a dry bulb temperature of 85 degrees F. a drift to the upper ranges of the normal distribution is more marked. Humidity apparently plays no part at this stage.

(iii.) At 90 degrees F. the average rectal temperature is at the extreme end or definitely outside the normal distribution, while at 95 degrees F. it is still higher. In neither of these temperatures does the degree of humidity seem to make any definite difference, except perhaps that up to 90 degrees F. there is a slight reduction with the highest humidity of 95 degrees over the temperatures at 85 degrees.

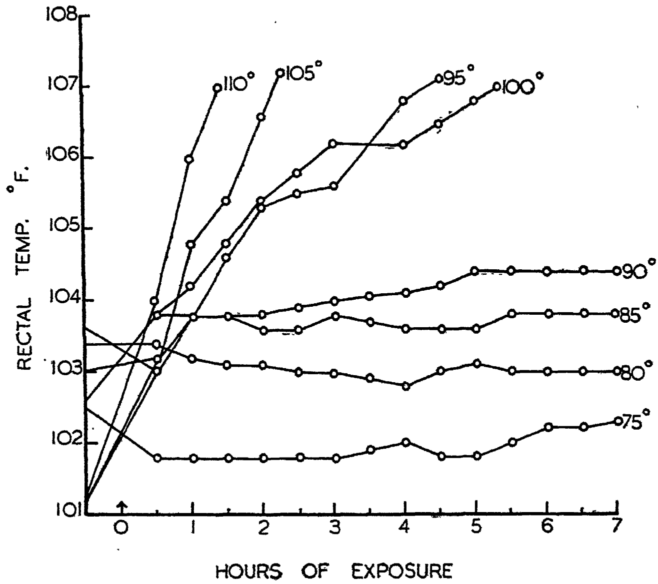
(iv.) At 100 degrees F. the rabbit had to be removed before seven hours had elapsed in all instances except that with the lowest humidity. With atmospheres of 105 degrees and 110 degrees F. the rabbit could withstand progressively less exposure without reaching the critical rectal temperature of 107 degrees F. At these temperatures, the degree of reaction was definitely and, for the most part, progressively reduced, by decreasing the humidity.



TEXT FIGURE 1.

Effect upon a Rabbit of Exposure to a Hot Atmosphere. (Dry Bulb 95 degrees F.; Relative Humidity, 75 per cent.)

Effect of Hydration.—The importance of maintaining bodily hydration within certain limits has been shown repeatedly for man [Gregory and Lee (1936)]. The position in the case of the rabbit was investigated by making the usual observations upon three different occasions in which it was supplied respectively with no water, half the water lost by evaporation, and water equal to the amount lost by evaporation. (For amounts see above.) The water was drunk by the rabbit as soon as it was placed in the tin.



ROOM TEMP. IS SHOWN WITHIN THE GRAPH

TEXT FIGURE 2.

Reaction of a Rabbit's Rectal Temperature to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

TABLE 2.

EFFECT OF THE AMOUNT OF DRINKING WATER SUPPLIED.

——	16ml/hr.	8 ml/hr.	Nil.
Av. Rect. Temp. °F.	[112·6]	[111·7]	[115·5]
Av. Pulse Rate (beats/min.)	[181]	[167]	[187]
Av. Resp. Rate (Resp./min.)	[1,133]	[1,345]	[1,589]
Av. Resp. Vol. (mls./hour)	[2,117]	[3,526]	[3,713]
Av. Tidal Vol. (mls.)	1·9	2·6	2·3
Av. Evap. Loss (gms./hr.)	18	12	15
Tolerance Time (mins.)	150	150	120

Figures enclosed in brackets have been weighted as described in the text for the duration of exposure tolerated.

In Table 2 is set out the average rectal temperature (calculated as above) for these trials and the tolerance times. It will be seen that

half replacement of the water loss was accompanied by a distinct improvement in tolerance, but that further additions of water afforded no further relief.

Acclimatisation and Season.—In Text Fig. 3 is given the effect of serial exposure and of season upon the rabbit's reactions to standard hot wet and hot dry atmospheres. Some suggestion of rapid acclimatisation to hot exposures is seen in the first few days of the first series in the hot wet atmosphere, but no evidence is seen in either of the other two series. This acclimatisation apparently breaks down later in the series, but this may have been associated with the onset of cooler weather, or with the less frequent manipulation experienced in the last two weeks rendering the animal less submissive on the day of measurement.

The effect of season is most marked. The average ante-room rectal temperature in summer was 102·52 degrees F. with an average deviation of 0·40, in autumn 100·62 degrees and 0·70, and in winter 102·60 degrees and 0·56. The lowering in autumn is thus significant. On the other hand, summer and winter yield almost identical ranges. Some difference between summer and winter is seen however in the rabbit's reactions to a hot wet atmosphere. In summer, the average rectal temperature in the hot wet room is 103·14 degrees F. with an average deviation of 0·55, in winter, 104·18 degrees F. and 0·26. When allowance is made for short-term acclimatisation in the summer series this difference is probably significant.

It would seem that the night temperatures are of more importance to acclimatisation than repeated exposure to hot dry temperatures, and that with the less severe trials of the hot wet room, at least, low night temperatures militate against acclimatisation. This is in accordance with the findings of Mills and Ogle (1933).

VARIATIONS IN REACTION.

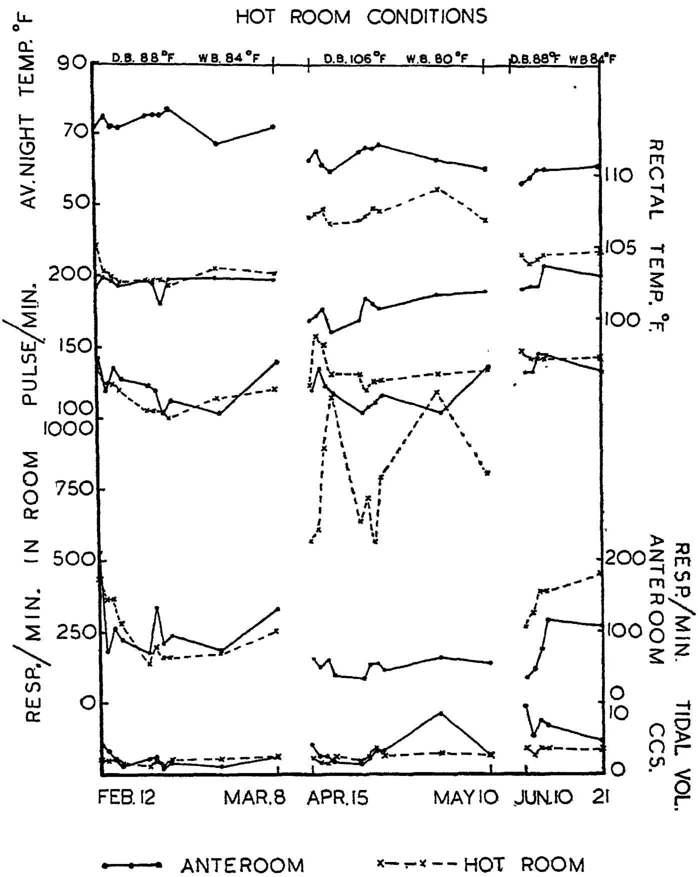
If season is not taken into account, the range of variation within the one individual is great. (Ante-room temperatures of rabbit A range from 103·6 degrees F. in winter to 99·0 degrees F. in autumn.) But even when seasonal factors are excluded, the range is still fairly wide. Thus rabbit A showed a variation in the ante-room on ten occasions within a month from 99·0 to 101·8 degrees F., and on five occasions within a week from 102·0 to 103·6 degrees F. Rabbit B showed less variation (100·5 to 101·8 degrees F.) over six weeks in winter. This range of variation is somewhat reduced when the animal is striving for adaptation to a hot climate.

PULSE RATE.

The pulse rate shows little rise with continued exposure to a room temperature which produces a marked rise in the rectal temperature. When pulse rates were entered into a temperature-humidity grid no definite trends with either of these factors was discernible. No significant difference in pulse rate behaviour was seen in the rabbit kept on different amounts of water in the hot room.

When, however, the effect of serial exposure and season is studied, differences of reaction become apparent (Text Fig. 3). As in the case of rectal temperature, there is a suggestion of acclimatisation in the summer series in the hot wet atmosphere, but none in the other two series of serial exposures. This also breaks down in the later weeks, and may be

due to either of the two causes mentioned. The average ante-room rate in summer was 123·2 with an average deviation of 11·2, in autumn 117·6 and 9·1 and in winter 136·8 and 5·8. Thus the autumn rate is significantly lower than the summer, but the winter rate is significantly higher than either. In summer the average pulse rate in the hot wet room is 116·4 with an average deviation of 9·4; in winter 142·6 and 1·9. This difference is quite significant. These findings suggest that the pulse rate is determined much more by seasonal factors, external or internal, than by the immediate environmental temperatures.



TEXT FIGURE 3.

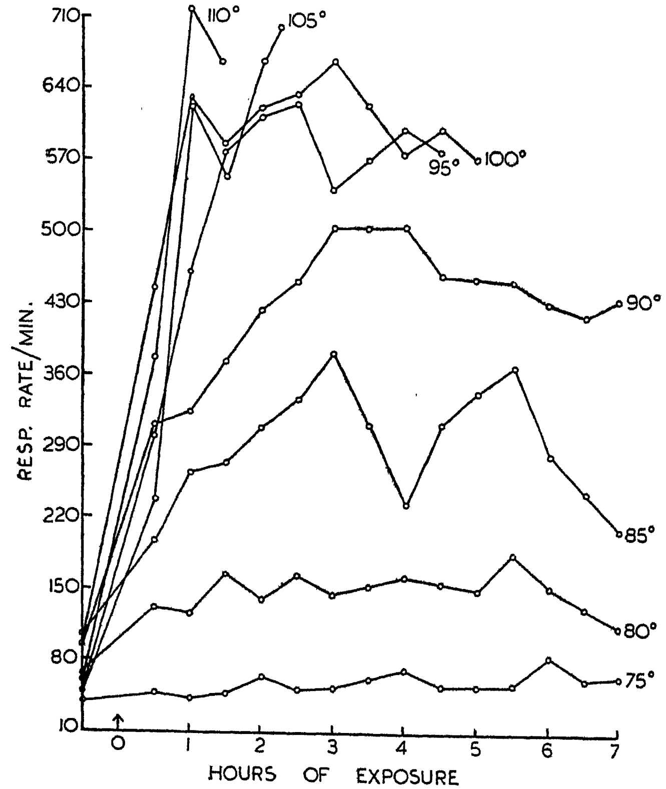
Effect of Repeated Exposure to Hot Atmospheres upon the Reactions of a Rabbit. (The hot-room figures represent the *average* reactions on the days in question, calculated as described in the text.)

As in the case of rectal temperature, the range of variation in the ante-room pulse rate in the same rabbit is fairly great, even when seasonal effects are excluded. In this case, the range of variation is not definitely reduced in the hot room.

RESPIRATORY FUNCTIONS.

General Behaviour.—In Text Fig. 1 appears a typical curve of the response of the respiratory rate under hot conditions. There is a

rapid early rise of respiratory rate followed by a slower later rise and the establishment of irregular fluctuations about a plateau, or some tendency to fall. With higher temperatures the equilibrium becomes less stable and higher. (Text Fig. 4.)



TEXT FIGURE 4.

Reaction of the Respiratory Rate of a Rabbit to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

Relative Effects of Temperature and Humidity on Respiratory Rate.—In Table 3 is given a temperature-humidity grid in respect of respiratory rate. The figures represent averages calculated as described above. Inspection reveals the following points:—

(i.) In some instances at a dry bulb temperature of 75 degrees F. and very definitely in all instances at 80 degrees F. the average respiratory rate is raised above that at 70 degrees F.

(ii.) As the dry bulb temperature rises the average rate is steadily increased.

(iii.) The effect of humidity is complex. The very high humidity of 95 per cent. is accompanied by a lower respiratory rate on all occasions than the lower humidity of 85 per cent., at which, at any one dry bulb temperature, the respiratory rate is at a maximum. With progressively lower humidities, the rates become in general progressively lower.

TABLE 3.
RESPIRATORY RATE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	76	97	131	158	457	532			
85 ..	130	137	262	473	537	582	[1,740]		
75 ..	90	81	148	168	533	421	[1,034]	[1,873]	
65 ..		57	141	275	392	[695]	[695]	[1,316]	[1,969]
55 ..			95	157	236	382	[468]	[948]	[2,062]
45 ..				105	207	263	[554]	[724]	[1,388]
35 ..						330	412	[890]	[489]
25 ..								[329]	[473]

The figures in each square represent the average respiratory rate per minute during the time the rabbit was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before seven hours had elapsed.

Respiratory Rate, Respiratory Volume and Tidal Volume.—Variations may occur not only in the rate of respiration, but also in the volume of tidal air inspired and expired with each breath, and thus in the total respiratory volume per minute. Simultaneous observations of respiratory volume and rate were made only in the acclimatisation series, i.e., in the standard hot dry atmosphere of 106 degrees F. dry bulb temperature and 80 degrees F. wet bulb and the standard hot wet atmosphere of 88 degrees F. dry bulb temperature and 85 degrees F. wet bulb. The average values obtained were:—

—	Resp. Rate.		Resp. Volume. ccs./min.		Tidal Volume. ccs.	
	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.
Rabbit A.—						
Hot Wet (Summer) ..	109	253	272	521	2·5	2·0
Hot Dry (Autumn) ..	54	[789]*	184	[1,868]	3·4	2·4
Hot Wet (Winter) ..	75	361	467	1,148	6·2	3·2
Rabbit B.—						
Hot Dry (Spring) ..	71	[962]	516	[1,675]	7·4	1·8

* For the significance of brackets *see* Table 1.

With the enormous increase in respiratory rate, there is not a comparable reduction in the tidal volume, a state of affairs at times remarkable which calls for further investigation. (Text Fig. 5.)

Effect of Hydration.—The figures given in Table 2 indicate a progressive improvement in respiratory reaction with the increased supply of drinking water up to full replacement.

Acclimatisation and Season.—The effects of serial exposure and season upon respiratory rate and volume appear in Text Fig. 3. As in the case of rectal temperature and pulse rate, there is some evidence of an acclimatisation in rate in the summer series of serial exposures, with some breakdown in the last two weeks. Unlike them, however, the rate undergoes a progressive increase in the five days of the winter series. Some new factor, probably not primarily concerned with exposure to heat is apparently operating here, as the ante-room values show a similar progressive rise. Respiratory volume, in general, follows the rate, the tidal volume fluctuating about a steady mean within any one series of exposures.

The effect of season is again noticeable. The following figures relate to ante-room values:—

—	Respiratory Rate.		Respiratory Volume. ccs./min.		Tidal Volume. ccs.	
	Average.	Av. Dev.	Average.	Av. Dev.	Average.	Av. Dev.
Summer	109	30·7	272	166	2·2	0·84
Autumn	54	7·8	184	90	3·2	1·27
Winter	75	29·0	467	158	6·6	1·52

It will be seen from this and Text Fig. 3 that the autumn rate is lower than the summer rate, while the winter rate shows a progressive return to the summer rate. On the other hand, the autumn tidal volume is somewhat greater than the summer value, while the winter values show a progressive fall from quite high to moderately high values. The rate in the hot wet room in winter is, on the average, higher than that in summer, as is also the tidal volume. The winter respiratory volume in the hot wet room is thus much greater (see below).

Variations in Reaction.—The range of variations within the one individual in both rate and tidal volume is wide, as the following figures for rabbit A show:—

	—	Summer (10).	Autumn (10).	Winter (5).	All Seasons.
Ante-Room.	Resp. Rate	72–212	37–63	35–115	35–212
	Resp. Volume	77–978	51–257*	232–788	51–978
	Tidal Volume	0·9–4·6	1·4–4·1*	4·2–9·3	0·9–9·3
Hot Wet Room.	Resp. Rate	136–438	..	262–447	136–447
	Resp. Volume	162–987	..	834–1,507	162–1,507
	Tidal Volume	1·2–2·7	..	2·5–3·4	1·2–3·4

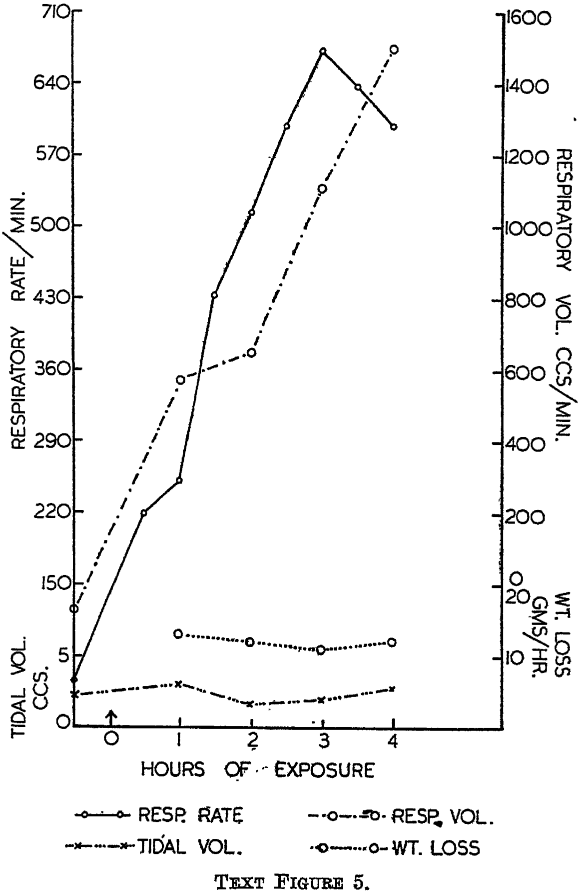
* One higher volume was recorded but was probably due to an error.

The range of variation in the hot wet room of respiratory rate and volume is reduced proportionately to their mean values as is the absolute range of variation in tidal volume, but it must be remembered that hot room values are averages, not single readings.

Correlation with Body Temperature.—If the temperature-humidity grids for rectal temperature and respiration (Tables 1 and 3) are compared, it will be seen that there is a very high positive correlation between the two. This is also seen in the course of any one exposure (Text Fig. 1). It should be noticed, however, that in the rabbit the

rise in respiratory rate is antecedent to the rise in rectal temperature. Thus the lowest room temperature to be accompanied by a definite rise in average rectal temperature is 80 degrees F., whereas definite rises of respiratory rate occur at 75 degrees F. The rapid rise of respiratory rate in Text Fig. 1 also suggests an anticipation of rather than a dependence upon rectal temperature.

The type of respiration is also fairly well correlated with rectal temperature; panting occurs at about 104 degrees F.



TEXT FIGURE 5.

Typical Reactions of Respiratory Functions and Evaporative Loss in the Rabbit. (Dry Bulb, 106 degrees F.; Relative Humidity, 33 per cent.)

EVAPORATION OF WATER.

General Behaviour.—Evaporative loss is low during exposure to intermediate temperatures, but shows a tendency to rise throughout the earlier part of the experiment. With higher temperatures (Text Fig. 1) it rises rapidly to a fairly stable value. In these, hourly weighings may fail to disclose the initial rise. With quite high temperatures a more or less continuous rise may be seen for as long as the animal remains in the hot room.

Relative Effects of Temperature and Humidity.—It is a fair assumption under the conditions of the experiments that the loss of weight by the cage containing both the animal and its water tin, less

a correction for evaporation from the tin directly, represents evaporation of water from the aniaml. Before this can be identified, however, with insensible evaporation in its physiological sense, an allowance has to be made for water exchange between the atmosphere and the fur and cage. The extent of the corrections required for this are being determined.

TABLE 4.

EVAPORATIVE LOSS GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	+ 4	+ 4	+ 5	+ 4	+ 1	+ 3			
85 ..	1	+ 2	0	+ 2	+ 1	2	[5]		
75 ..	2	1	1	2	2	5	[12]		
65 ..		2	3	5	7	[3]	[11]	[23]	
55 ..			2	3	5	12	[12]	[28]	
45 ..				3	10	10	[13]	[19]	[17]
35 ..						12	8	..	[17]
25 ..								[18]	[33]

The figures in each square represent the average rate of evaporative loss in grams per hour during the time the rabbit was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before 7 hours had elapsed.

In Table 4 is given the temperature-humidity grid in respect of evaporative loss. It will be seen that evaporative loss increases in general with dry-bulb temperature and decreases with humidity. The temperature at which this increase first makes its appearance becomes progressively higher as the humidity is increased. It is not known at present how this would be affected by corrections for water exchange between the fur and the atmosphere.

Effect of Hydration.—No definite alterations in the rate of evaporation were found when the animal was kept on different amounts of water in the hot room (Table 2).

Correlation with Respiration.—If the temperature-humidity grids in respect of respiratory rate (Table 3) and evaporative loss (Table 4) are compared, it will be seen that some correlation exists in the intermediate percentages of humidity, as room temperature rises. When reactions in atmospheres of different humidity are compared, however, this correlation is lost. At any one temperature, as the relative humidity decreases, so does the respiratory rate, but the evaporative loss rises. This does not, however, negative a dependence, at least, in part of evaporation upon respiratory rate, as the rate of evaporation from the respiratory tract would tend to increase with the degree of pulmonary ventilation, and decrease with the relative humidity. When the individual curves for the duration of exposure in intermediate temperatures are examined, the correlation of evaporative loss with respiratory rate is more evident.

This correlation would probably be more evident if figures were available for respiratory volume rather than rate. Some idea of the

extent to which pulmonary evaporation could account for the evaporative loss may be obtained by assuming that the expired air leaves in a state of 95 per cent. saturation at the temperature of the body, and using the figures given above (p. 5).

Exp.	Inspired Air.			Expired Air.		Av. R. Vol. 1/hr.	Water Loss.	
	D.B.	R.H.	H_2O/1.	R.T.	H_2O/1.		Calc.	Observ.
Hot Wet (Summer) ..	88	90	·027	103·1	·051	31	0·7	0·8
Hot Dry (Autumn) ..	106	33	·015	105·1	·052	71	2·6	12·0

POWERS OF HEAT REGULATION.

Comparable Atmospheric Conditions.—In Text Fig. 6 the results of Tables 1 and 3 are expressed in graphic form to permit a general analysis of the relative effects of dry-bulb temperature and humidity upon the rectal temperature and respiratory rate. It will be seen from this that both temperature and humidity play a part in determining the reaction of the rabbit, but that temperature is in general the more important. At high humidities there is some indication of a slight reversal of effect. At high temperatures reduction in humidity has proportionately more effect.

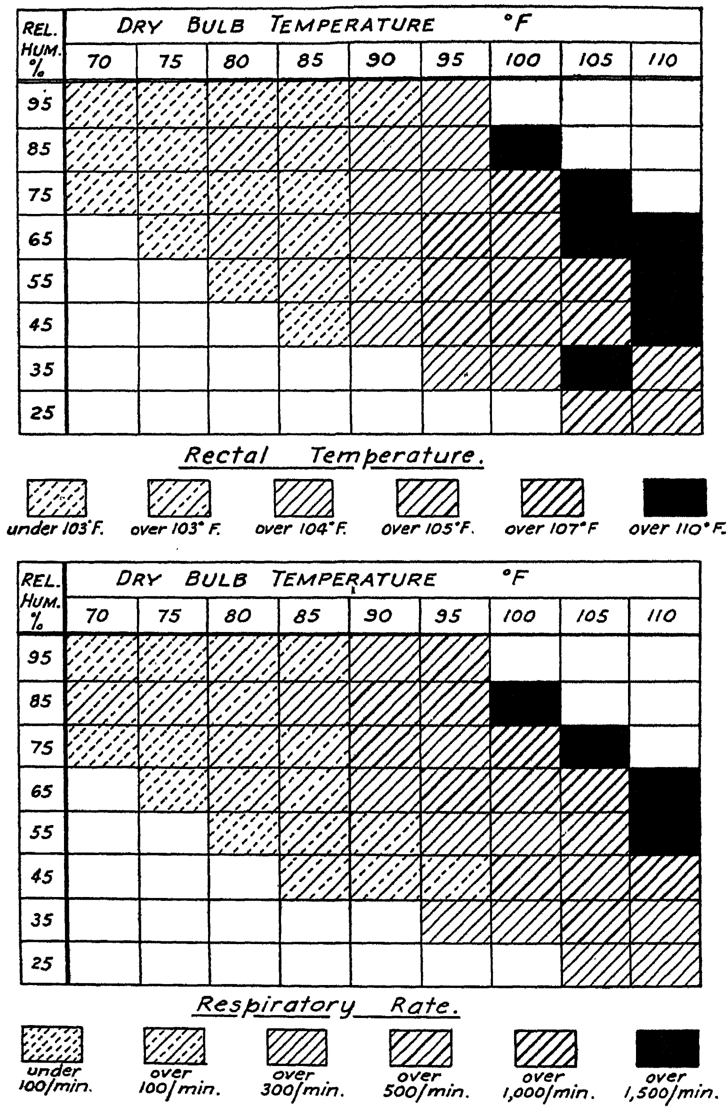
Critical Temperatures.—A shade dry-bulb temperature of 75 degrees F. marks the upper limit at which the rabbit could maintain its equilibrium undisturbed for seven hours. At this atmospheric temperature respiratory reactions begin to appear. At an atmospheric temperature of 80 degrees F. some rise in rectal temperature occurs.

At a rectal temperature of about 104 degrees F. open-mouthed panting replaces the rapid but closed-mouthed breathing maintained thereto. A rectal temperature of 107 degrees F. is near the limit of continued existence as an integrated organism.

The rabbit succeeded in remaining for seven hours at a dry bulb temperature of 100 degrees F. only when the humidity was reduced to 35 per cent. Above this temperature seven hours exposure was not tolerated.

Methods of Heat Regulation.—Heat loss by radiation and conduction must be somewhat restricted by the furry covering of the angora rabbit. This interference is somewhat reduced by the large ears and by the attitude of relaxation adopted under hot conditions. Apart from the adoption of a relaxed posture and an increased peripheral blood flow, these channels of heat loss are not susceptible to increase under hot conditions, and the increased blood flow would not appear to be very large in view of the small increase found in pulse rate.

It would appear, therefore, that any adaptation the rabbit might be able to make to increasingly hot environments would depend largely upon increasing evaporation of water. That such an increase in evaporation does take place is clearly seen from the figures quoted above. An appreciable portion of this can be accounted for by the increased respiratory volume. Dribbling of saliva from the mouth would account for a further proportion of the water loss at high temperatures, but as the rabbit, unlike the cat and guinea pig [Herrington (1940)] does not spread it over its fur, this is of little value in heat regulation. While the consensus of opinion [Kuno (1934)] seems to be that a rise of temperature has little effect upon the rate of insensible cutaneous evaporation in man, evidence has been produced that a marked rise



TEXT FIGURE 6.

Diagrammatic Representation of the Comparative Effects of Temperature and Humidity upon the Reactions of the Rabbit.

occurs in rabbits [Eimer (1927), Nagayama (1932)]. It is generally believed that a rabbit possesses few if any sweat glands. Both of these claims are being further examined.

Increasing the respiratory volume is a common method of heat regulation in birds and mammals, but the special feature of this in the rabbit is the enormous rise in rate, with a much smaller corresponding reduction in tidal volume. While the rabbit is much better off for moist mucous membrane in the upper respiratory tract than the fowl, it has not the advantage possessed by the dog of a large open mouth and drooling tongue. The deeper alveolar portion of the lung must, therefore, share in the hyperventilation for evaporation and create by the consequent acapnia a major problem for the regulation of the acid-base balance.

A further indication of the importance to the rabbit of evaporation of its own body water is the improvement in general reactions, but more especially respiratory reactions, obtained when it is permitted adequate water to drink (Table 2).

Acclimatisation.—That it is possible for the rabbit to show progressively reduced reaction to repeated exposure to a hot environment is shown by the reaction of rabbit A in the hot wet room in the summer series. Such an acclimatisation was not obtained in either rabbit in the hot dry room, or in rabbit A in the hot wet room in winter. The conditions for the production of acclimatisation in the rabbit would appear to be somewhat precarious and will require further careful study.

On the other hand, the rabbit does show variations in behaviour, both in the ante-room and in the hot room with season. These variations may be in the nature of a long-term true acclimatisation intimately related to the actual conditions experienced, or they may represent the result of a seasonal rhythm in, let us say, the endocrine balance, related only in a general way to the actual temperatures experienced. The incidence, variability and causation of such seasonal change also require extended study.

Heat Effects.—At a rectal temperature of about 103·5 degrees F. the rabbit sits quietly upon its haunches and is disinclined to move. At 104 degrees F. it stretches out and lies upon its side. At this level also the rapid breathing turns to rapid panting and salivation occurs. If water is provided it drinks with avidity and makes repeated attempts to upset the tin over itself. At a rectal temperature of 107 degrees F. it is obviously in distress, but can still stand and carry out ordinary movements. In these experiments we did not take the animal beyond this stage.

SUMMARY.

Experiments are described in which two white male angora rabbits were subjected to hot atmospheres of different temperatures and humidity, for periods up to seven hours. The effect of varying the supply of drinking water, of repeated exposure, and of season upon the reactions was also studied. Observations were made upon rectal temperature, pulse rate, respiratory rate, respiratory volume, tidal volume, evaporative loss and general behaviour. The following observations were made and conclusions reached:—

(1) Rectal temperature begins to rise above normal when the dry bulb temperature reaches 80-85 degrees F. When the dry bulb temperature is 100 degrees F. or more, the rabbit is unable to tolerate the conditions for seven hours. Respiratory rate, on the other hand, begins to rise at a dry bulb temperature of 75 degrees F. Very rapid rates are obtained (e.g., 720 respirations per minute).

(2) Progressive decrease of the relative humidity below 75 per cent. effects a definite and progressive improvement in the reactions of both rectal temperature and respiration at higher dry bulb temperatures. The improvement is less marked at lower temperatures.

(3) The supply of drinking water equivalent to half the water being evaporated from the animal produces a definite improvement in the reactions of the rectal temperature and respiratory functions of a rabbit exposed to a temperature of 106 degrees F. with a wet bulb temperature of 80 degrees F. The full replacement of water loss is accompanied by a

further improvement in the respiratory reactions but not in the rectal temperature.

(4) The pulse rate shows little tendency to rise with rectal temperature or respiratory rate upon exposure to heat.

(5) Acclimatisation, as revealed by a decrease in the rise of rectal temperature, respiratory rate and respiratory volume with exposure was obtained in one series of repeated daily exposures to a hot wet atmosphere (D.B. 88 degrees F. W.B. 85 degrees F.). It was not obtained in a similar winter series or in a series of exposures to a hot dry atmosphere (D.B. 106 degrees F. W.B. 80 degrees F.).

(6) Seasonal variation in the values of the different functions investigated were obtained both in the normal temperature room and in the hot room. These variations are complex and require further study. They appear to influence reactions more strongly than atmospheric conditions recently experienced by the test rabbit.

(7) In the course of the rise of respiratory rate with exposure to heat, the tidal volume is not correspondingly reduced, so that the respiratory volume is also greatly increased.

(8) The rate of water evaporation from the rabbit increases in general with the dry bulb temperature and decreases with humidity. In hot dry atmospheres the increased pulmonary ventilation could account for about one quarter of the evaporation. Dribbling of saliva would also account for a large part.

(9) The range of variation in one individual of the different functions investigated is large, particularly if seasonal effects are not excluded. This variability may be somewhat reduced in the hot room as compared with the temperate room.

(10) The rabbit is very largely dependent upon respiratory evaporation for the regulation of its body temperature in hot environments. This regulation is brought into action before body temperature rises. It confers upon the rabbit only a limited power of adaptation to hot atmospheres.

ACKNOWLEDGMENTS.

The investigations here reported were carried out under the Commonwealth Research Projects Scheme for Universities, financed by the Commonwealth Government, through the Council for Scientific and Industrial Research. Valuable assistance and advice were received from officers of the University Departments of Veterinary Science and Biology and the State Department of Agriculture and Stock. We are also indebted to the Commonwealth Meteorological Bureau for data.

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REACTIONS OF THE PIG TO HOT ATMOSPHERES.

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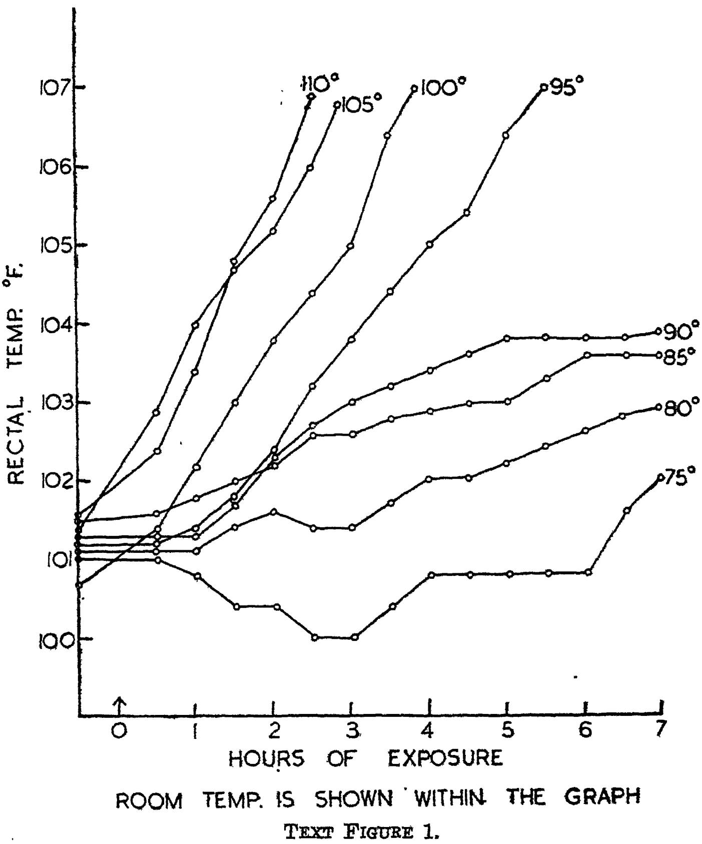
(SIX TEXT FIGURES.)

(*Read before the Royal Society of Queensland, 30th June, 1941.*)

INTRODUCTION.

Systematic comparative studies of the reactions of domestic mammals and birds to hot atmospheres are few, but no animal has been neglected in this respect as much as the pig. Yet such studies on this animal are important from both the economic and the scientific point of view. Each year in the hot weather pigs die, apparently from the effect of heat, particularly in the process of trucking. The fact that the home of the pig is in the tropics and that when the domestic pig goes wild it, too, can prosper in the tropics raises interesting questions as to the reason for the domestic animal's susceptibility. Although more animals, more breeds, and more variations in conditions are being studied, it is considered worth while to report these observations at this stage.



TEXT FIGURE 1.

Reaction of the Pig's Rectal Temperature to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.)

The methods of investigation were essentially those used in parallel studies upon the rabbit [Lee, Robinson, and Hines (1941)]. Because of the slower respiratory rate, counts were made by sight and it was possible to include counts made without the use of the mask. Three young male Berkshire pigs of 130 lb. average weight were used. One was used for the acclimatisation series, one for the acclimatisation and effective temperature series, and one for the hydration series.

In the acclimatisation series, the observations were made in the hot wet room in February (summer), and in the hot dry room in April (autumn) on Pig A, and in the hot dry room in May (winter) on Pig B. The first set was not repeated in winter.

The pigs were kept upon a diet of commercial pig food containing 15 per cent. protein, together with pumpkin, given every evening. Free water-drinking was at all times permitted except during exposure to the hot atmosphere in the hydration and acclimatisation series.

RECTAL TEMPERATURE.

General Behaviour.—With the mildest degree of heating used here (70 degrees F.) the rectal temperature falls at first but later rises somewhat above normal. With intermediate degrees of heating (up to 90 degrees F.) the rectal temperature rises, but progresses towards some kind of equilibrium. With higher degrees of heating the rectal temperature rises with increasing rapidity without showing any indication of establishing an equilibrium (Text Fig. 1). In this respect the pig resembles the rabbit, except that it gives a somewhat greater response at the lower temperatures.

Relative Effects of Temperature and Humidity.—Table 1 presents a temperature-humidity grid showing the average rectal temperatures exhibited by a pig when exposed for seven hours to atmospheres of different composition. The figures shown in brackets have been weighted as previously described [Lee, Robinson, and Hines (1941)] to compensate for the reduced time of exposure in the corresponding trials. The actual time of exposure is indicated by the figures in the bottom right-hand corner of the square. The following points will be noticed:—

(i.) Below a dry bulb temperature of 85 degrees F. neither temperature nor humidity produces any regular effect upon the rectal temperature.

(ii.) At a dry bulb temperature of 85 degrees F. definite rises of rectal temperature are obtained with intermediate but not with higher humidities. At 90 degrees F. these rises are rather more constantly present with all humidities.

(iii.) At 95 degrees F. the pig had in general to be removed before seven hours had elapsed when the humidity was 65 per cent. or over. At 100 degrees F. this was also true, but the tolerance times were further reduced.

(iv.) At 105 degrees F. and above the pig was not able to tolerate any atmosphere for seven hours.

(v.) The degree of humidity has little regular effect upon the pig's reaction until temperatures of 95 degrees F. and over are reached. The higher the temperature the greater is the effect of humidity.

TABLE 1.

RECTAL TEMPERATURE GRID.

Relative Humidity. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	100·5	100·8	100·8	101·1	102·1	[103·2] 5·5			
85 ..	101·1	101·4	101·4	101·2	101·8	[103·9] 6·5	[104·5] 5·3		
75 ..	100·3	101·0	101·0	100·7	103·1	103·7	[105·3] 4·8	[107·6] 2·8	
65 ..		100·9	101·9	102·7	102·9	[104·2] 5·5	[106·1] 3·8	[109·9] 2·8	[110·0] 2·5
55 ..			101·9	104·3	102·4	102·7	103·3	[106·2] 4·0	[106·0] 3·5
45 ..			-	103·4	102·8	102·2	102·9	[103·9] 5·0	[103·5] 4·9
35 ..						102·8	103·4	[104·2] 4·8	[103·1] 5·5
25 ..								[103·6] 5·3	[103·8] 4·5

The figures in each square represent the average rectal temperature in degrees F. during the time the pig was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before seven hours had elapsed. The number below the bracket indicates the hours that the animal remained in the room.

Effect of Hydration.—In Table 2 is given the rectal temperature of a pig after two hours' exposure to a hot dry atmosphere (dry bulb 106 degrees F., wet bulb 80 degrees F.) and provided on separate occasions with no water, 120 ccs. per hour and 240 ccs. per hour, respectively, for drinking. It will be seen that the rectal temperature was definitely reduced by giving water equivalent to half of that lost by evaporation, but that it was not further reduced by increasing the water supply to full replacement.

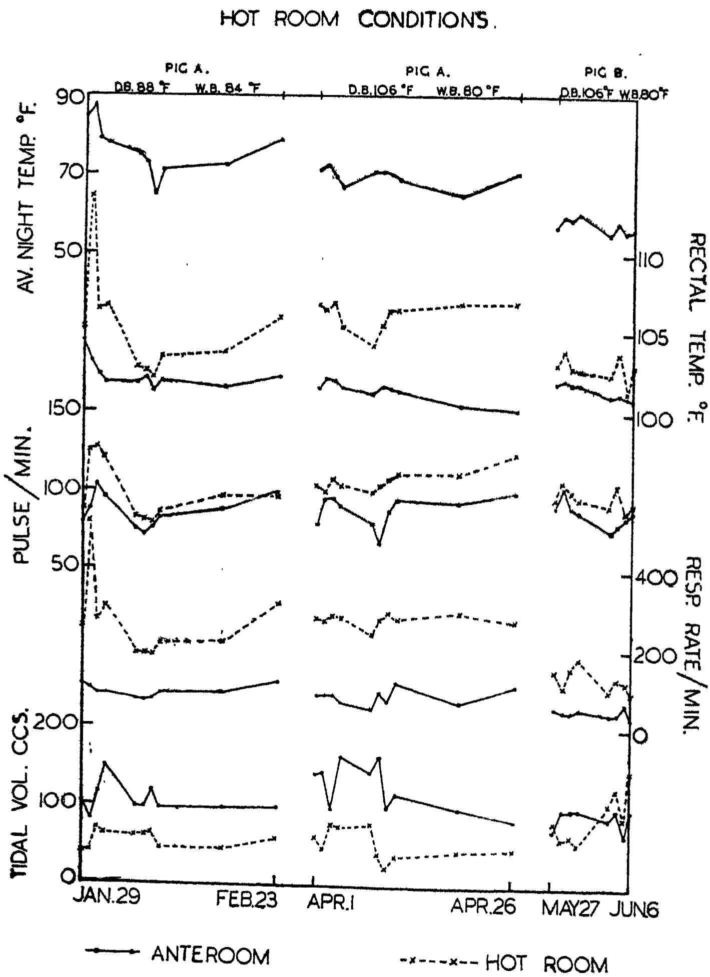
TABLE 2.

EFFECT OF THE AMOUNT OF DRINKING WATER SUPPLIED.

(Reaction at the end of the second hour.)

—	240 ml./hr.	120 ml./hr.	Nil.
Rectal Temp. °F.	105·6	103·4	107·4
Pulse Rate (beats/min.)	104	84	144
Resp. Rate (Free) (Resp./min.) .. .. Resp. Rate (Mask) Resp./min.)	184 120	160 116	264 170
Resp. Vol. (litres/min.)	8·8	8·8	9·0
Tidal Vol. (Mils.)	73	76	53
Evap. Loss (gms./hr.)	175	125	270 (?)
Tolerance Time (Mins.)	183	210	110

Acclimatisation and Season.—In Text Fig. 2 appear the ante-room and average hot room reactions of a pig repeatedly exposed to high temperatures. It will be seen that when the night temperature was high, the rectal temperature in the ante-room was also high, and that when high night temperatures came between successive exposures to the hot room the pig was unable to tolerate the exposure for seven hours, even though the room temperature was below the usual critical figure (95 degrees F.). When allowance is made for high night temperatures, it will be seen that there is no evidence of any acclimatisation developing in response to repeated exposure with either the hot wet or the hot dry room.



TEXT FIGURE 2.

Effect of Repeated Exposure to Hot Atmospheres upon the Reactions of the Pig. The Hot-room figures for D.B. 88 degrees F., W.B. 84 degrees F., represent the average reactions on the days in question, calculated as described in the text, while those for D.B. 106 degrees F., W.B. 80 degrees F., are readings after the second hour of exposure.

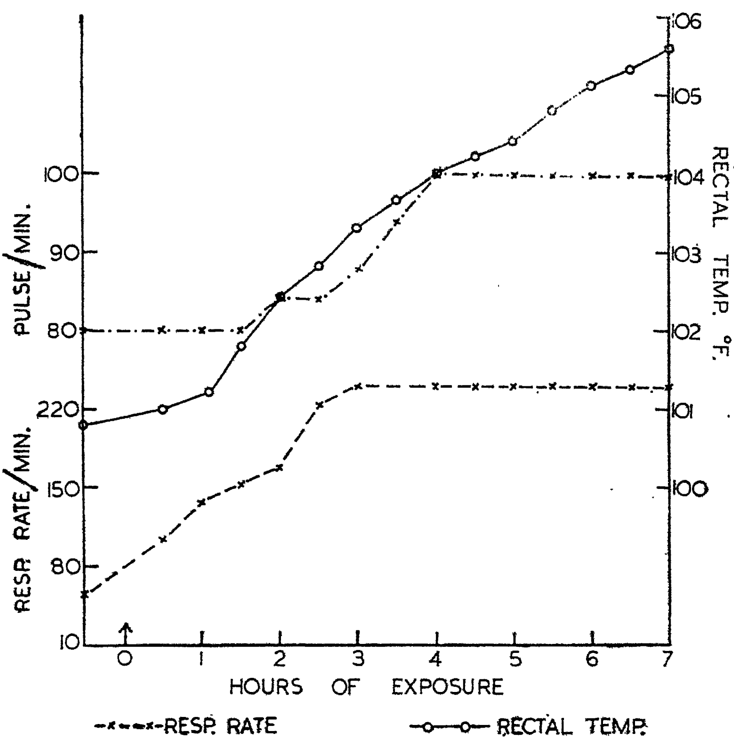
Variations in Reaction.—The ante-room rectal temperature of Pig A varied on ten occasions in summer from 101·3 to 104·5 degrees F.,

but when the five days following high night temperatures are excluded, the range falls to 101·3 to 102·1 degrees F. In autumn the range upon ten occasions was from 100·2 to 102·2 degrees F. With Pig B the range upon eight occasions in the winter was from 100·8 to 102·1 degrees F. With Pig C, the range upon eight occasions in the winter was from 101·8 to 103·2 degrees F. It will be seen from these figures that the range of rectal temperature in any one individual pig, and even between different pigs is not great, unless the temperatures to which it is exposed are above 78 degrees F.

At high atmospheric temperatures, however, the constancy is not always preserved, as will be deduced from the irregularities in the temperature-humidity grid (Table 1). Different individuals do not show the same sensitivity to heat (Text Fig. 2, Pigs A and B). This may be associated with body size.

PULSE RATE.

General Behaviour.—In distinction from the fowl [Yeates, Lee, and Hines (1941)], and to a large extent from the rabbit [Lee, Robinson, and Hines (1941)], the pig shows a moderate but definite response to high temperatures in its pulse rate, which follows rather closely the curve of rectal temperature (Text Fig. 3).



TEXT FIGURE 3.

Effect upon the Pig of Exposure to a Hot Atmosphere. (Dry Bulb, 100 degrees F.; Relative Humidity, 55 per cent.)

Relative Effects of Temperature and Humidity.—In Table 3 appears the temperature-humidity grid in respect of the pulse rate. It will be seen that the average pulse rate tends to rise above normal when the room temperature is 90 degrees F. This rise tends to increase with the temperature of the room, but more particularly with the higher humidities.

TABLE 3.

PULSE RATE GRID.

Relative Humidity. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	73	72	76	74	85	[95]			
85 ..	73	80	77	73	80	[91]	[98]		
75 ..	79	80	82	76	89	93	[97]	[121]	
65 ..		85	102	98	84	[118]	[107]	[129]	[128]
55 ..			105	105	87	91	91	[112]	[122]
45 ..				100	95	85	85	[97]	[97]
35 ..						98	88	[107]	[113]
25 ..								[104]	[122]

The figures in each square represent the average pulse rate per minute during the time the pig was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before seven hours had elapsed.

Effect of Hydration.—From Table 2 it will be seen that when the pig was given water equivalent to half the evaporated loss there was a marked reduction in the pulse rate as compared with the response when no water was given. Further increases in water intake were not accompanied by any further reduction.

Acclimatisation and Season.—In Text Fig. 2 some tendency may be seen on the part of the pulse rate in the ante-room to follow the night temperature during the summer series, but this is offset by the somewhat higher rates in the autumn series. The average hot-room pulse rates behave in much the same fashion as the average hot-room rectal temperatures. The effect of night temperatures would seem to influence the pulse rate also. There is no evidence of any acclimatisation through repeated exposure.

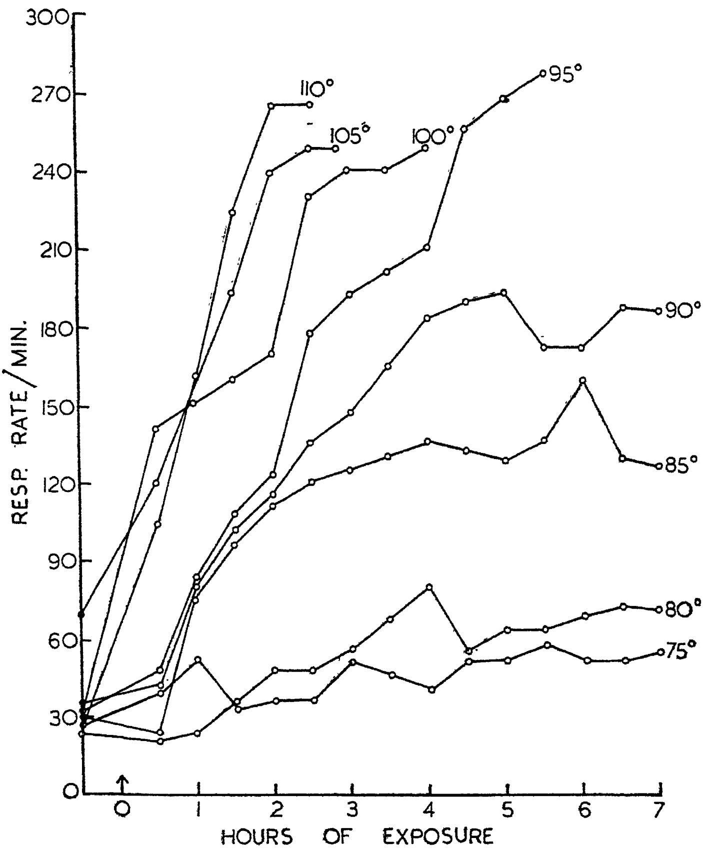
Variations in Reaction.—The range of variations in the pulse rate measured in the ante-room is not great—72–104 (Pig A, summer, ten measurements), 68–100 (Pig A, autumn, ten measurements), 76–104 (Pig B, winter, eight measurements), and 76–128 (Pig C, winter, eight measurements).

Correlation with Rectal Temperature.—A fairly close correlation between the pulse rate and rectal temperature is seen both in the curves during a single exposure to hot conditions and in the temperature-humidity grids.

RESPIRATORY FUNCTIONS.

General Behaviour.—The general behaviour of respiratory rate, respiratory volume, and tidal volume during exposure to heat is seen

in Text Fig. 5. It will be seen that the rate rises fairly rapidly to a plateau which is maintained throughout the rest of the exposure. The pig establishes some kind of a plateau even when the rectal temperature is rising rapidly and showing no signs of reaching an equilibrium (Text Fig. 4). Respiratory volume also rises, but not to the same extent. The tidal volume falls as the rate rises. Both of these latter functions come to equilibrium at the same time as the respiratory rate.



TEXT FIGURE 4.

Reactions of the Respiratory Rate of the Pig to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

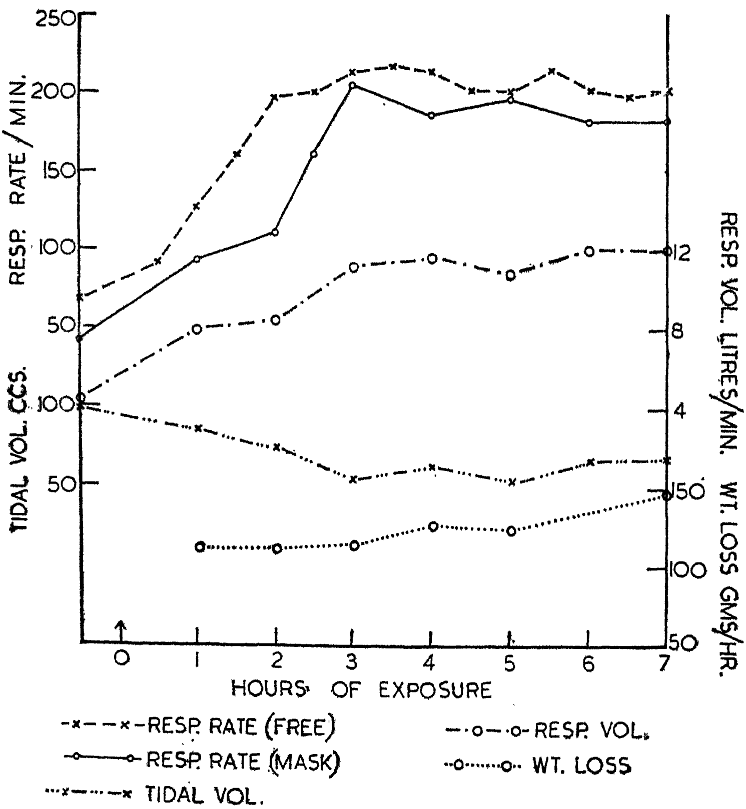
Relative Effects of Temperature and Humidity upon Respiratory Rate.—In Table 4 is given the temperature-humidity grid in respect of respiratory rate, counted without the use of a mask. It will be seen that, in general, the average rate rises with room temperatures of 85 degrees F. and above. A reduction of humidity is not accompanied by any reduction in respiratory rate until a room temperature of 95 degrees F. is reached, but above this level the effect is marked.

Respiratory Rate, Respiratory Volume, and Tidal Volume.—Simultaneous observations of the respiratory rate and volume were made only in the standard hot-dry (dry bulb 106 degrees F., wet bulb

80 degrees F.) and standard hot-wet atmosphere (dry bulb 88 degrees F., wet bulb 85 degrees F.). The values obtained are given here and in Text Fig. 5, together with the rates as measured without the mask:—

—	Resp. Rate. (Free).		Resp. Rate (Mask).		Resp. Vol. (Mask). l./min.		Tidal Vol. (Mask.) ccs.	
	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.
Hot Wet (Summer)* ..	78	197	47	161	4·9	9·3	104	58
Hot Dry (Autumn)† ..	84	276	41	195	5·0	10·1	129	52

* Hot wet room values are average for day.
† Hot dry room values are those at end of second hour.



TEXT FIGURE 5.
Typical Reactions of Respiratory Functions and Evaporative Loss in the Pig. (Dry Bulb, 88 degrees F.; Relative Humidity, 80 per cent.)

It will be seen that while the rate is not increased to the enormous values found in the rabbit, the tidal volume is halved in the hot-wet room, and more than halved in the hot-dry. This definite reduction of tidal volume is seen also in Text Fig. 2. The use of the mask has only a slight repressive effect upon the rate.

Effect of Hydration.—As with rectal temperature and pulse rate, the respiratory rate and tidal volume are definitely reduced when half replacement water is given, but further increases in water supply are not accompanied by further reductions (Table 2). Respiratory volume remains unaltered.

TABLE 4.

RESPIRATORY RATE GRID.

Relative Humidity. %	Dry Bulb Temperature °F. 70	75	80	85	90	95	100	105	110
95 ..	38	25	57	70	104	[165]			
85 ..	40	56	65	69	70	[193]	[210]		
75 ..	40	41	34	21	141	197	[236]	[432]	
65 ..		50	52	110	139	[194]	[295]	[392]	[417]
55 ..			40	182	137	140	197	[298]	[345]
45 ..				138	127	115	140	[228]	[162]
35 ..						81	177	[172]	[189]
25 ..								[183]	[140]

The figures in each square represent the average respiratory rate per minute during the time the pig was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107°F. before seven hours had elapsed.

Acclimatisation and Season.—The respiratory rate in the ante-room (Text Fig. 2) is apparently affected to some extent by the night temperatures. Season is without any effect. The hot-room rates are related to night temperatures in much the same way as the rectal temperatures. No acclimatisation effects are noticeable.

Respiratory volume shows some increase with high night temperatures in both the ante-room and hot room. Tidal volume is not regularly affected by nightly temperatures or seasonal influences.

Variations in Reaction.—The following figures indicate the extremes of variation in the ante-room and hot-room values of the respiratory functions in pigs:—

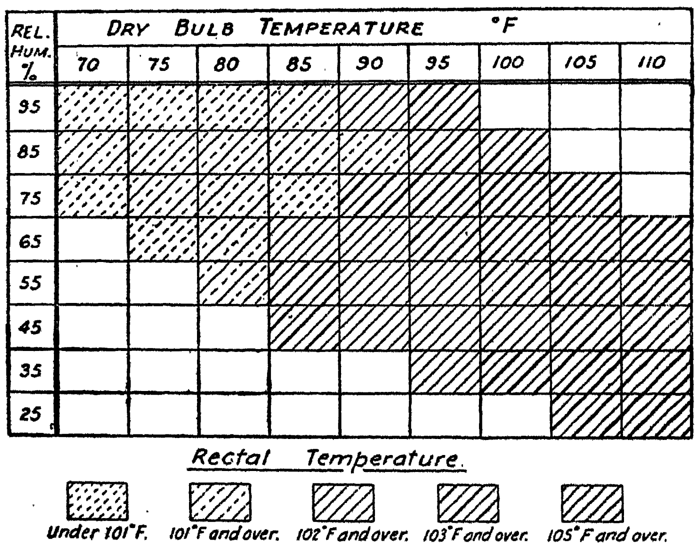
	—	Pig A. (Summer) 10 Days.	Pig A. (Autumn) 10 Days.	Pig B. (Autumn) 8 Days.	Pig C. (Winter) 8 Days.
Ante-Room.	Resp. Rate (Free)	68–110	52–120	28–64	32–60
	Resp. Rate (Mask)	36–100	27–70	27–60	28–44
	Resp. Vol. (Mask) l/min. ..	4·4–10·4	3·0–7·2	3·4–4·3	2·4–5·6
	Tidal Vol. ccs.	82–150	86–167	67–100	86–127
Hot Wet Room.*	Resp. Rate (Free)	183–219	..	..	..
	Resp. Rate (Mask)	147–175	..	..	..
	Resp. Vol. (Mask) l/min. ..	8·3–10·6	..	..	..
	Tidal Vol. ccs.	49–66	..	..	..
Hot Dry Room.†	Resp. Rate (Free)	..	240–292	96–180	..
	Resp. Rate (Mask)	..	150–232	48–96	..
	Resp. Vol. (Mask) l/min. ..	..	6·0–12·0	4·0–12·0	..
	Tidal Vol. ccs.	..	27–78	58–125	..

* Average figures for period of exposure (7 hours).

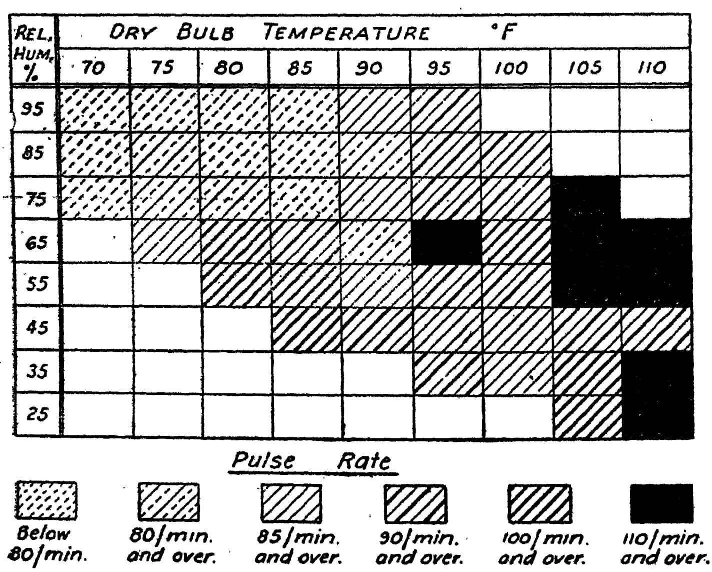
† Figures taken at the end of the second hour.

The ranges are fairly large.

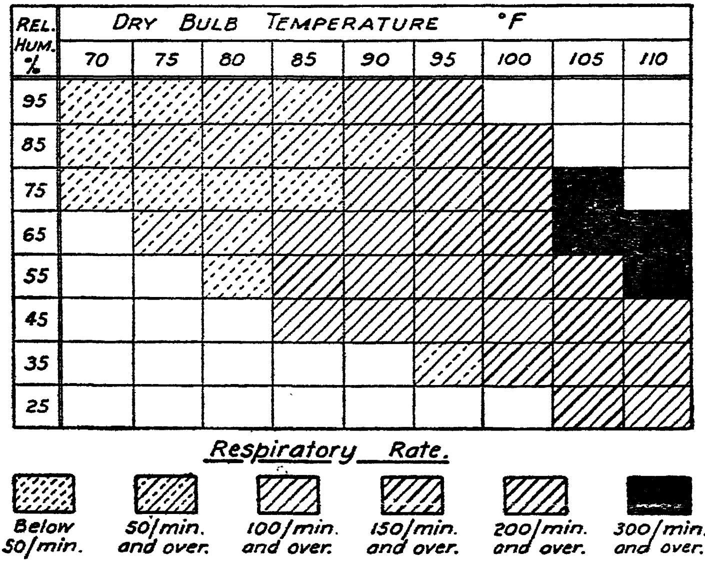
Correlation with Body Temperature.—If the temperature-humidity grids for rectal temperature and respiratory rate (Tables 1 and 4) and the curves of Text Figs. 1 and 4 are compared it will be seen that there is a high degree of correlation between the two reactions. If anything, respiratory reaction anticipates the rise of rectal temperature, but the lead is not marked. The type of respiration appears to be closely related to the rectal temperature, panting occurring when the rectal temperature reaches 102·5 degrees F.



TEXT FIGURE 6A.



TEXT FIGURE 6B.



TEXT FIGURE 6c.

Diagrammatic Representation of the Comparative Effects of Temperature and Humidity upon the Reaction of the Pig.

EVAPORATION OF WATER.

General Behaviour.—In Text Fig. 5 appears the curve for evaporative loss from a pig exposed to a hot-wet atmosphere (dry bulb 88 degrees F., wet bulb 85 degrees F.). The rate rises slowly throughout the period of exposure. At higher temperatures and at lower humidities the rate rises rapidly throughout the period. Quite considerable amounts of moisture are evaporated. (These figures do not include saliva lost by dribbling, which was collected, measured, and deducted from the gross weight loss.)

Effect of Hydration.—The period of exposure tolerated by the pig without water was too short for a reliable estimate of evaporative loss to be made. Conclusions on this point, therefore, must remain in abeyance.

Correlation with Respiration.—Comparison of figures for respiratory rate and evaporative loss, as well as of the corresponding curves of Text Fig. 5, indicate that the dependence of evaporative loss upon respiratory rate is not by any means complete. The extent to which respiratory reaction could account for the evaporative loss is indicated by the following calculations:—

Atmosphere.	Inspired Air gms. H_2O/1.	Expired Air gms. H_2O/1.	Av. Resp. Vol. 1/hr.	Water Loss (gms./hr.).	
				Calc.	Observ.
Hot Wet (Summer) ..	·027	·051	618	11	119
Hot Dry (Autumn) ..	·015	·052	624	28	230

POWERS OF HEAT REGULATION.

Comparable Atmospheric Conditions.—In Text Fig. 6A, 6B, and 6C the results of Tables 1, 3, and 4 are expressed in graphic form. It will be seen from these that while both temperature and humidity play a part in determining the reactions of the pig, temperature is the more powerful factor.

Critical Temperatures.—At room temperatures of 85–90 degrees F. the pig begins to show evidence of disturbance of its equilibrium.

Open-mouthed panting replaces closed-mouth breathing when the rectal temperature reaches 102·5 degrees F. A rectal temperature of 107 degrees F. is near the limit of continued existence as an integrated organism.

The pig can tolerate atmospheres of 95 degrees F. and 100 degrees F. for seven hours only when the relative humidity is below 65 per cent. It is unable to withstand atmospheres of 105 degrees F. for seven hours at any humidity.

Methods of Heat Regulation.—As opposed to the state of affairs in the rabbit, heat exchange between the pig's skin and the environment through the channels of radiation and conduction is not restricted by a dense furry covering. That this opportunity is utilised is suggested by the response of the pulse rate.

Relaxation of posture cannot mean much to the distinctly rotund domestic pig. Its habit of lying down is probably more effective in conserving heat production.

It is commonly stated that the pig has no sweat glands upon its general body surface. Although it salivates profusely (up to 500 ccs. per hour in very hot atmospheres), this saliva dribbles on to the ground and is largely lost to useful evaporation.

While the pig does not possess the large drooling tongue of the dog, nevertheless its mouth is fairly large and the anterior surface of the snout is kept moist by nasal secretions, licking, and perhaps also by sweat glands. It therefore possesses a fairly extensive moist mucous membrane at the entrance to the upper respiratory tract over which it is able to play an increased respiratory volume. It is able to do this also without a corresponding degree of over-ventilation of the lung alveoli, whereby it avoids much of the risk of alkalosis incurred by the rabbit. When insufficient water is given to replace the water evaporated the ventilation is increased.

It is apparent that increased respiratory ventilation can account for only a part of the increased evaporation, however. It would appear that there must be an important increase of insensible cutaneous evaporation in the pig at high temperatures, with low humidities.

In spite of these many advantages over the rabbit, however, the pig is just as sensitive to heat. Equally important disadvantages must, therefore, be present. One of these is probably the fatness of the animal, giving it a superficial layer of material of poor heat conductivity, and a reduced surface area in proportion to mass. This reduction of surface area extends also to the ears.

Acclimatisation.—No evidence of acclimatisation to repeated exposures was obtained with the pig. On the other hand, hot nights between successive exposures were found to render the animal more sensitive to heat.

Heat Effects.—The first sign of the effect of heat on the pig is the onset of drowsiness, which occurs at a rectal temperature between 101 degrees and 102 degrees F. With a further rise of temperature this drowsiness disappears and open-mouthed panting with respirations of about 160 per minute occurs at 102·5 degrees F. A further increase in rectal temperature is accompanied by an increase in respiratory rate to a maximum of 280 per minute. Marked salivation occurs at these temperatures, amounting in extreme cases to as much as 500 ccs. per hour.

With a rectal temperature of 106 degrees F. the pig becomes very restless, its respirations are very laboured, and if water is provided it drinks with avidity and makes determined efforts to upset the tin over itself. At 107 degrees F. it is obviously in distress but can still stand. In these experiments we did not take the animal beyond this stage.

Sousing the pig with water affords a very effective method of resuscitation. In ten minutes the rectal temperature falls 3 degrees F. and the respirations from 280 to 100 per minute.

Repeated exposure to extreme conditions had no deleterious effects upon the growth or meat quality of the animals. Pig A grew from 120 lb. on 29th January to 233 lb. on 26th April, and Pig B from 100 lb. on 27th May to 212 lb. on 19th November. Reports received from the bacon factory were to the effect that the pigs were perfectly normal for their weight and age.

SUMMARY.

Experiments are described in which three male pigs were subjected to hot atmospheres of different temperatures and humidity, for periods up to seven hours. The following observations were made and conclusions reached:—

1. Rectal temperature begins to rise above normal when the dry bulb temperature reaches 85–90 degrees F. When the dry bulb temperature reaches 95 degrees F. the pig is unable to tolerate an atmosphere of relative humidity 65 per cent. or above for seven hours. When the temperature reaches 105 degrees F. it is unable to tolerate an atmosphere of any humidity.

2. Respiratory rate behaves in much the same fashion. The maximum rate obtained was 280 per minute.

3. The pulse rate tends to rise with the rectal temperature during exposure to heat.

4. Decrease of the relative humidity is accompanied by definite improvements in the reactions of the rectal temperature, pulse rate, and respiratory rate at high temperatures in the higher ranges of humidity. At lower temperatures and humidities this is not so apparent.

5. Half replacement of water lost at high temperatures is accompanied by marked improvement in most reactions and an increase in the tolerance time.

6. No evidence was obtained of acclimatisation to repeated exposures to hot atmospheres. High night temperatures between exposures increased the pig's sensitivity to heat.

7. As respiratory rates rise with exposure to heat, the respiratory volume rises also, but not in proportion, as the tidal volume is reduced to a half or less.

8. With a humidity of 95 per cent. the rate of water evaporation rises steadily with room temperature, with intermediate humidities only when the room temperature exceeds 85 degrees F. At high humidities the rate of evaporation is definitely restricted.

9. The range of variation in the one individual of rectal temperature and pulse rate is not large, but that of the respiratory functions is fairly large.

10. The pig makes use of radiation and conduction from exposed skin for heat regulation where these channels are still open, but its principal method is evaporation from a moist mouth, snout, and upper respiratory tract by an increased respiratory volume, and insensible evaporation from the skin.

11. Profuse salivation, up to 500 ccs. per hour, occurs at high temperatures, but this is largely wasted by dribbling.

12. Repeated exposure to extreme conditions did not affect the growth or meat quality of the pigs used. Hosing is an effective means of resuscitation.

ACKNOWLEDGMENTS.

The investigations here reported were carried out under the Commonwealth Research Projects Scheme for Universities, financed by the Commonwealth Government, through the Council for Scientific and Industrial Research. Valuable assistance and advice were received from officers of the University Departments of Veterinary Science and Biology and the State Department of Agriculture and Stock. The Agricultural High School and College kindly supplied the experimental animals.

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REACTIONS OF THE CAT TO HOT ATMOSPHERES.

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(SIX TEXT FIGURES.)

(*Read before the Royal Society of Queensland, 25th August,* 1941.)

INTRODUCTION.

More studies have been made upon the reactions of the cat to hot atmospheres than upon those of any other domestic animal except the dog. In spite of this, however, the comparative effects of different combinations of the atmospheric variables such as temperature and humidity seem to have been neglected. To fill this want and to link up our series of experiments with those carried out elsewhere, the cat has been included in our investigations.

The methods of investigations were essentially those used in parallel studies upon the rabbit. [Lee, Robinson, and Hines (1941)]. Because of the slower respiratory rate counts were made by sight, and it was possible to include counts made without the use of the mask.

In the "acclimatisation series" one cat (A) was used for the hot wet room in February-March, and a second cat (B) for the hot dry room in April-May. A second set of experiments in the hot wet room was not carried out.

The cats, males of no specific breed, were kept upon a diet of meat and milk, given every evening. Free water drinking was at all times permitted except during exposure to the hot atmosphere in the hydration and acclimatisation series.

RECTAL TEMPERATURE.

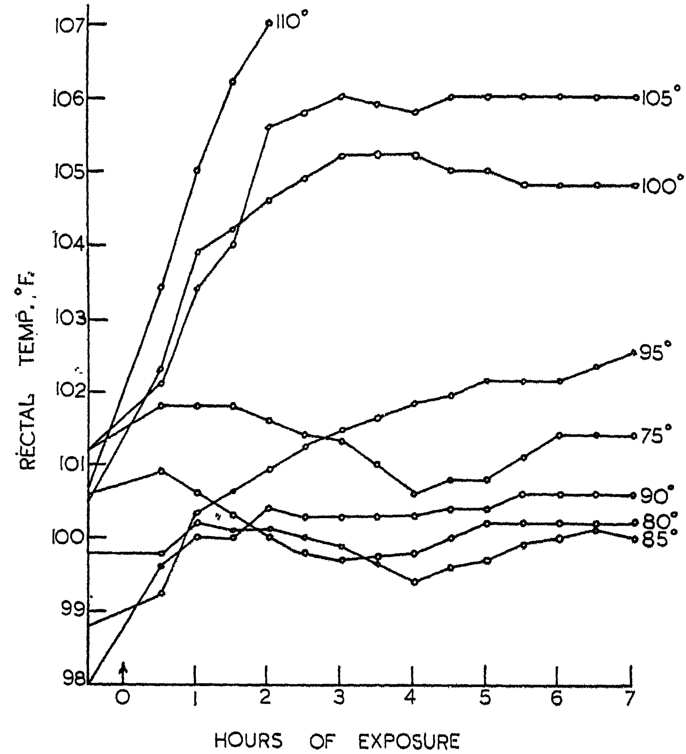
General Behaviour.—With only mild degrees of heating the rectal temperature actually falls. With higher degrees it fluctuates or rises slowly. At moderately high room temperatures it rises rapidly at first, but then establishes an equilibrium. Only at the highest temperature employed here (110 degrees F.) does it fail to reach an equilibrium. (Text Fig. 1.)

Relative Effects of Temperature and Humidity.—Table 1 presents a temperature-humidity grid showing the average rectal temperatures exhibited by a cat when exposed for seven hours to atmospheres of different composition. The figures shown in brackets have been weighted as previously described [Yeates, Lee, and Hines (1941)] to compensate for the reduced time of exposure in the corresponding trials. The actual time of exposure is indicated by the figures in the bottom right-hand corner of the square. The following points will be noticed:—

(i.) With the highest humidities the average rectal temperature rises steadily throughout with increasing room temperatures.

(ii.) With intermediate and low humidities the effect is irregular until a room temperature of 90 degrees F. is reached.

(iii.) The rectal temperature is in every case higher at a room temperature of 95 degrees F. than at one of 90 degrees F. With further rises of room temperature the effect becomes progressively greater.



ROOM TEMP. IS SHOWN WITHIN THE GRAPH

TEXT FIGURE 1.

Reaction of a Cat's Rectal Temperature to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

TABLE 1.

RECTAL TEMPERATURE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	98·4	98·9	99·8	100·6	102·1	104·3			
85 ..	98·6	98·3	99·1	99·4	101·0	102·6	104·7		
75 ..	100·2	99·0	101·3	100·0	101·3	102·8	104·7	[116·9] 1·8	
65 ..		101·3	100·2	99·9	100·2	101·2	104·3	105·1	[115·5] 2·0
55 ..			100·3	100·3	101·9	102·0	103·7	105·1	[112·3] 2·7
45 ..				102·2	101·9	102·5	102·6	103·8	[106·3] 5·0
35 ..						102·1	103·0	103·8	103·7
25 ..								105·1	[104·1] 5·6

The figures in each square represent the average rectal temperature in °F. during the time the cat was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed. The number below the bracket indicates the hours that the animal remained in the room.

(iv.) A humidity of 95 per cent. at nearly all room temperatures results in a higher rectal temperature. Otherwise, humidity has no regular effect below a room temperature of 100 degrees F.

(v.) At 100 degrees F. and above, reducing the humidity has a sparing action, but it is still more marked in the upper ranges of humidity.

Effect of Hydration.—In Table 2 is set out the average rectal temperature of a cat exposed to a hot dry climate (Dry Bulb 106 degrees F., Wet bulb 80 degrees F.) and receiving by oral injection on separate occasions no water, 8 ccs. per hour, and 16 ccs. per hour respectively. It will be seen that the rectal temperature was not essentially different upon the three occasions.

Acclimatisation.—The following figures were obtained upon a cat exposed repeatedly to a hot wet climate (Dry bulb 88 degrees F., Wet bulb 85 degrees F.) for five and a half days a week for four weeks.

Date	Feb. 12	Feb. 13	Feb. 14	Feb. 15	Feb. 19	Feb. 20	Feb. 21	Feb. 22	Mar. 1	Mar. 8
Av. R. T. °F. ..	102·3	102·6	102·0	101·7	102·1	102·6	101·4	101·9	101·3	101·4

There is here some evidence of moderate-term acclimatisation. (Ante-room temperatures showed no such trend.) A similar series carried out in the hot dry room showed no such acclimatisation.

TABLE 2.

EFFECT OF THE AMOUNT OF DRINKING WATER SUPPLIED.

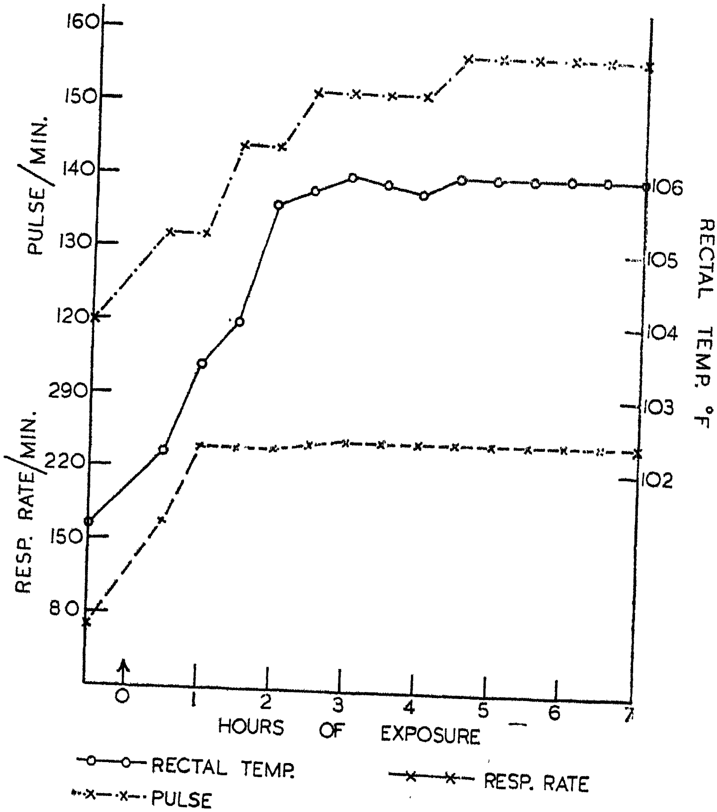
—	16 ccs./hr.	8 ccs./hr.	Nil.
Av. Rectal Temp. °F.	104·0	103·5	104·1
Av. Pulse Rate (beats/min.)	138	135	137
Av. Resp. Rate (Resp./min.) (Free) ..	180	165	175
Av. Resp. Rate (Resp./min.) (Mask) ..	118	102	110
Av. Resp. Vol. (ml./min.)	1,653	1,856	2,306
Av. Tidal Vol. (mls.)	14	18	21
Av. Evap. Loss (gms./hour)	18	16	16

Variations in Reaction.—The range of variation in the normal rectal temperature of an individual cat is a moderate one (Cat A 100·6-102·3 degrees F. in 10 measurements; Cat B 99·0-100·8 degrees F. in 9 measurements; Cat. E 98·4-100·0 degrees F. in 8 measurements). The variation under hot conditions is no greater (101·3-102·6 degrees F. in the hot wet and 103·9-105·4 degrees F. in the hot dry room). The effect of season as distinct from individual variation was not established.

PULSE RATE.

General Behaviour.—In distinction from the fowl [Yeates, Lee, and Hines, (1941)] and also to a large extent from the rabbit [Lee, Robinson and Hines (1941)], the cat shows a moderate but definite response to high temperatures in its pulse rate, which follows rather closely the curve of the rectal temperature. (Text Fig. 2).

Relative Effects of Temperature and Humidity.—In Table 3 is given the temperature humidity grid in respect of pulse rate. The same general conclusions can be drawn as were drawn for the rectal temperature, except that the pulse is more generally reactive and a rise of room temperature less regularly effective in producing further rises at lower humidities.



TEXT FIGURE 2.
Effect upon a Cat of Exposure to a Hot Atmosphere (Dry Bulb, 105 degrees F.; Relative Humidity, 65 per cent.)

Effect of Hydration.—Variations in the supply of water produced no significant differences in the pulse rate (Table 2).

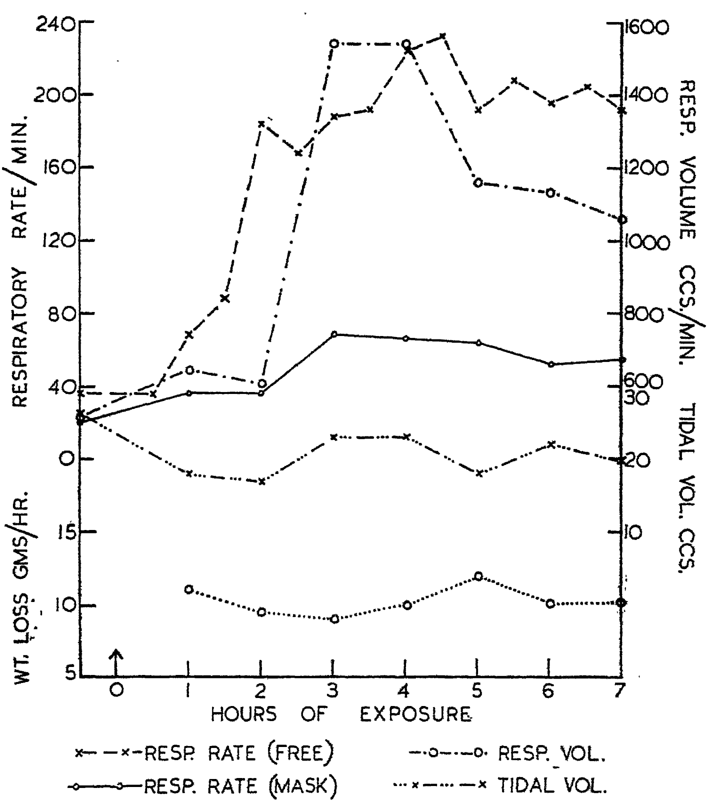
Acclimatisation.—Repeated exposures to a hot wet atmosphere (see above) produced some reduction in average pulse rate although no alteration occurred over the period in the rate observed in the ante-room. This may be considered a true acclimatisation. While a similar reduction occurred in the hot dry room during repeated exposures, there was upon this occasion a similar reduction in the ante-room rate, so that seasonal factors are more likely to be the cause here.

Variations in Reaction.—The range of variation in the pulse-rate of one individual either in the ante-room or under given conditions of heating is not great. (120-148, 100-124, 108-134, 97-127 in four different series of 8-10 measurements).

TABLE 3.
PULSE RATE GRID.

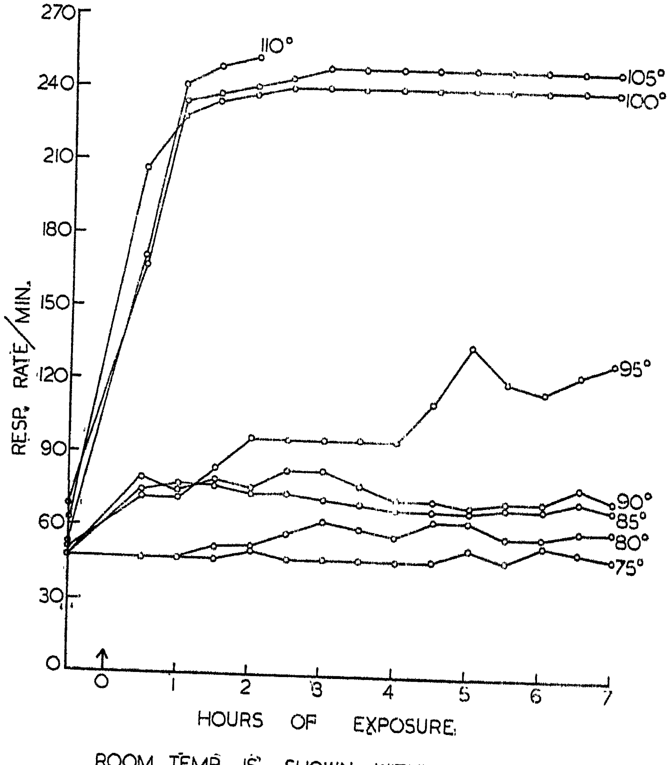
Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	109	116	128	136	139	149			
85 ..	110	125	129	120	130	137	145		
75 ..	113	123	135	130	125	140	143	[239]	
65 ..		148	151	140	129	141	144	147	[195]
55 ..			126	155	147	130	147	141	[192]
45 ..				146	136	141	131	148	[153]
35 ..						113	130	139	144
25 ..								153	[142]

The figures in each square represent the average pulse rate per minute during the time the cat was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.



TEXT FIGURE 3.
Typical Reactions of Respiratory Functions and Evaporative Loss in the Cat.
(Dry Bulb, 106 degrees F.; Relative Humidity, 33 per cent.)

Correlation with Rectal Temperature.—A fairly close correlation between the pulse rate and rectal temperature is seen in the curves during a single exposure to hot conditions. In the temperature-humidity grids, the main point of difference is the reactivity of the pulse-rate to intermediate temperatures at low humidities.



TEXT FIGURE 4.

Reaction of the Respiratory Rate of a Cat to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

RESPIRATORY FUNCTIONS.

General Behaviour.—The general behaviour of respiratory rate, respiratory volume and tidal volume during exposure to heat is seen in Text Fig. 3. It will be seen that the rate rises rather rapidly to a higher value which is maintained throughout the exposure. Unlike the rabbit, the cat establishes such a plateau under the highest temperatures used here, temperatures it is unable to tolerate for seven hours. (Text Fig. 4.)

Respiratory volume follows respiratory rates rather closely, the tidal volume changing but little throughout the day.

Relative Effects of Temperature and humidity upon Respiratory Rate.—In Table 4 is given the temperature-humidity grid in respect of respiratory rate, counted without the use of a mask. Except for a little irregularity at lower temperatures the rate rises with room temperature at any one level of relative humidity, and the rise becomes increasingly more rapid. At room temperatures of 80 degrees F. and

above a reduction of humidity has a pronounced effect in lowering the respiratory rate. While this is more marked in the higher ranges of humidity, it tends to progress with progressive reduction in humidity.

TABLE 4.

RESPIRATORY RATE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	53	58	65	72	146	218			
85 ..	60	50	61	76	91	192	226		
75 ..	51	51	56	62	74	178	227	[625]	
65 ..		50	56	72	73	101	225	228	[546]
55 ..			53	70	73	115	206	217	[492]
45 ..				56	63	123	146	217	[282]
35 ..						101	127	205	196
25 ..								170	[200]

The figures in each square represent the average respiratory rate per minute during the time the cat was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.

Respiratory Rate, Respiratory Volume and Tidal Volume.—Simultaneous observations of the respiratory rate and volume were made only in the standard hot dry atmosphere (Dry bulb 106 degrees F. Wet bulb 80 degrees F.), and hot wet atmosphere (Dry bulb 88 degrees F., Wet bulb 85 degrees F.). The average values obtained are given here, together with the rates as measured without the mask.

—	Resp. Rate (Free).		Resp. Rate (Mask).		Resp. Vol. (Mask). ccs/min.		Tidal Vol. (Mask). ccs.	
	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.
Cat A—Hot Wet (Summer)	40	45	29	28	604	553	22	20
Cat B—Hot Dry (Autumn)	40	167	22	56	483	858	22	16
Cat C—Hot Dry (Spring)	61	171	53	116	765	1,566	15	13

As in the case of the rabbit, the tidal volume is not greatly reduced with the increase in rate occurring in the hot room, but this is probably of less consequence here, as the whole respiratory reaction is less marked than in the rabbit. The repressive effect of a mask upon respiratory rate is well seen. It is not known to what extent this alters the respiratory volume.

Effect of Hydration.—From Table 2 it will be seen that while increasing the amount of water supplied by mouth has no constant effect upon the respiratory rate in the hot room, it is accompanied by a marked reduction in tidal volume and thus in respiratory volume. It would appear that the supply of adequate water reduces considerably the risk of over-ventilation.

Acclimatisation.—No acclimatisation effects were discernible in the respiratory reactions of cats subjected to repeated exposure to hot atmospheres.

Variations in Reaction.—The following figures indicate the extremes of variation in the reactions of different cats.

	—	Cat A. (Summer) 10 days.	Cat B. (Autumn) 9 days.	Cat C. (Spring) 6 days.
Ante-Room.	Resp. Rate (Free)	32–48	36–56	40–72
	Resp. Rate (Mask)	24–36	18–28	40–72
	Resp. Vol. (Mask)	232–876	334–681	361–1,152
	Tidal Vol. (Mask)	7–33	12–26	8–20
Hot Wet Room.	Resp. Rate (Free)	31–55	..	..
	Resp. Rate (Mask)	27–29	..	..
	Resp. Vol. (Mask)	435–675	..	..
	Tidal Vol. (Mask)	15–25	..	..
Hot Dry Room.	Resp. Rate (Free)	..	145–201	158–194
	Resp. Rate (Mask)	..	43–99	111–129
	Resp. Vol. (Mask)	..	689–1,035	1,219–1,939
	Tidal Vol. (Mask)	..	9–20	11–15

The range of variation is relatively large, although not as large as in the rabbit.

Correlation with Body Temperature.—While there is a general correlation between rectal temperature and respiratory rate, close comparison of the grids (Tables 1 and 4) for the two reactions shows that the relationship is not a close one. Respiratory rate is closely related to room temperature and fairly closely to room humidity and the relationship is probably a fairly simple operation of cause and effect. Rectal temperature is related to both room temperature and respiratory rates only towards the upper extremes of the grid, which would be in keeping with a delayed or a residual relationship to both. In other words, it is quite possible that rectal temperature only rises appreciably when increased respiratory activity is unable fully to compensate for a deterioration of room conditions. Also in accordance with this is the rapid rise of respiratory rate after exposure commences, before there is any marked rise in rectal temperature. (Text Fig. 2.)

The type of respiration, however, is possibly better related to rectal temperature; panting occurs between 102·0 and 103·4 degrees F.

EVAPORATION OF WATER.

General Behaviour.—The general behaviour of the rate of water evaporation during exposure of a cat to a hot dry atmosphere is seen in Text Fig. 3. At intermediate temperatures it rises slowly during the first few hours, and then remains fairly constant. At high temperatures it tends to rise fairly steeply throughout the exposure.

Relative Effects of Temperature and Humidity.—In Table 5 is given the temperature-humidity grid in respect of evaporative loss. It will be seen that evaporative loss is not much affected until a room temperature of 95 degrees F. is reached. Above this it is markedly increased. At high humidities, an initial uptake of moisture by the fur slightly complicates the picture.

TABLE 5.

EVAPORATIVE LOSS GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	+2	+2	+1	0	4	8			
85 ..	1	0	+1	0	1	6	15		
75 ..	2	2	1	4	2	6	19		
65 ..		5	1	2	4	3	20	20	[79]
55 ..			3	2	3	9	14	17	[43]
45 ..				5	3	3	8	15	[26]
35 ..						3	5	13	13
25 ..								11	[10]

The figures in each square represent the average evaporative loss in grams per hour during the time the cat was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.

Effect of Hydration.—No significant alterations in the rate of evaporative loss were found when the animal was kept on different amounts of water in the hot room (Table 2).

Correlation with Respiration.—Comparison of the temperature-humidity grids for respiratory rates and evaporative loss (Tables 4 and 5) indicates only an imperfect degree of correlation. Text Fig. 3 gives a further indication of the divergences which exist between respiratory rate and evaporation.

As in the case of the rabbit, respiratory exchange could account for the observed rate of water loss in the hot wet atmosphere, but can account for only 1·8 grams per hour in the hot dry room as compared with the 12·0 grams per hour actually lost. It is true that the use of the mask reduces the natural rate of respiration, but even if it is assumed that the tidal volume of each natural respiration is as great as that of each respiration with the mask, the respiratory exchange could account for only 4·5 grams per hour.

POWERS OF HEAT REGULATION.

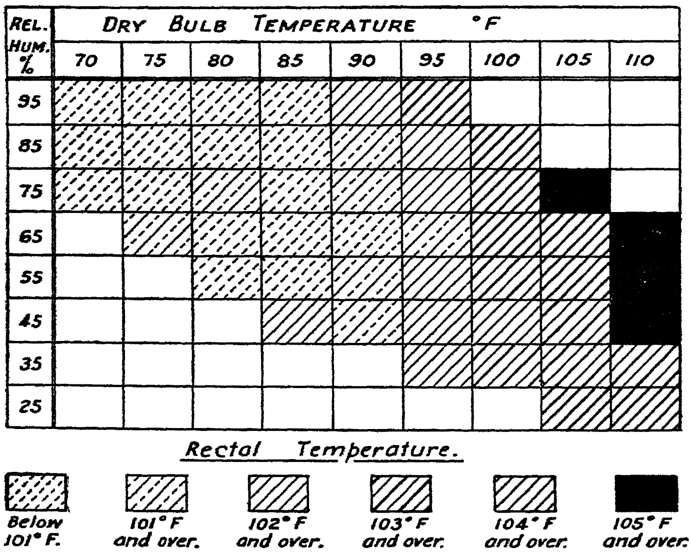
Comparable Atmospheric Conditions.—In Text Fig. 5 the results of Tables 1, 3 and 4 are expressed in graphic form. It will be seen from this that both temperature and humidity are important factors in determining the reactions of a cat.

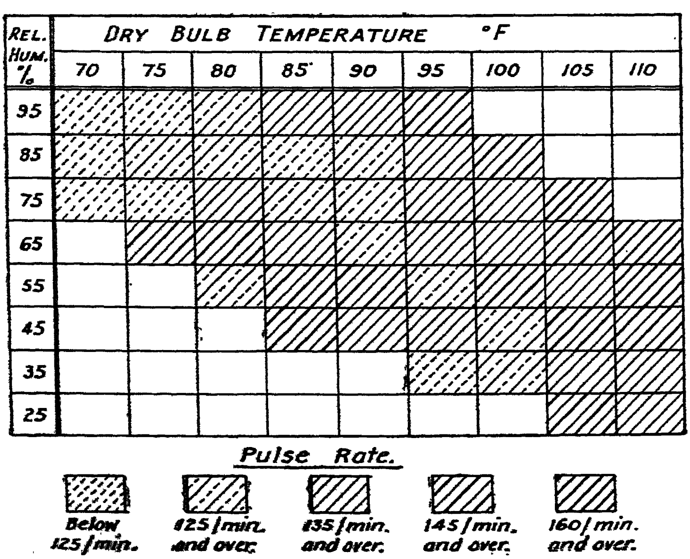
Critical Temperatures.—At a room temperature of 85 degrees F. evidence of some disturbance in the cat's equilibrium often makes its appearance.

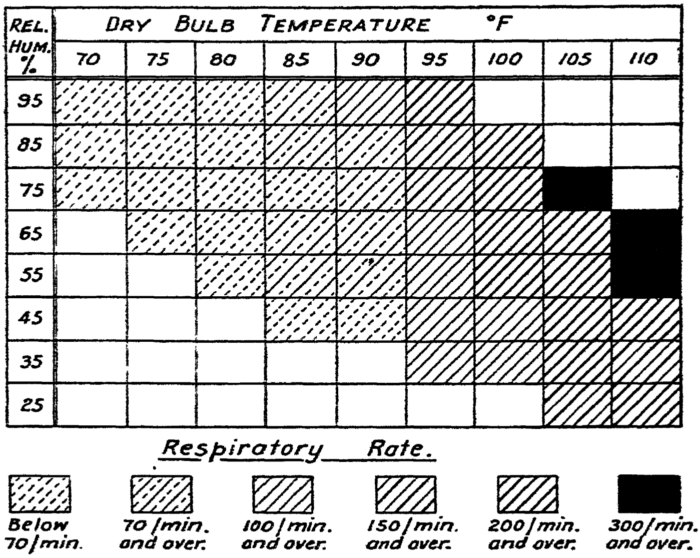
Open-mouthed panting replaces closed-mouth breathing when the rectal temperature approaches 103 degrees F. A rectal temperature of 107 degrees F. is near the limit of continued existence as an integrated organism.

The cat can tolerate a room temperature of 105 degrees F. for seven hours at humidities of 65 per cent. and below, and a room temperature of 110 degrees F. for almost seven hours at humidities of 35 per cent. and below.

Methods of Heat Regulation.—As in the case of the rabbit, heat loss by radiation and conduction must be somewhat restricted by the cat's fur. Relaxation of posture gives some relief, but the cat possesses no large glabrous ears to help it. Increased respiratory volume permits increased evaporation from the respiratory tract, but the cat also makes use of its saliva by spreading it over its coat. This latter method probably accounts in large measure for the superiority of the cat over







TEXT FIGURE 5.

Diagrammatic Representation of the Comparative Effects of Temperature and Humidity upon the Reactions of the Cat.

the rabbit, and relieves the respiratory apparatus of much of the responsibility of temperature regulation, with a corresponding reduction in the risk of alkalosis. For effective evaporation from the upper respiratory tract and the supply of saliva for its coat, maintenance of bodily hydration is important. When water replacement is inadequate, the respiration becomes deeper and the risk of acapnia greater. It was not possible to determine in these experiments the true insensible cutaneous perspiration. The few sweat glands of the paws are probably of little importance for heat regulation. The rise in pulse rate with high temperatures is probably associated with the efficacy of salivary evaporation.

Acclimatisation.—There is some evidence that an acclimatisation in the reactions of rectal temperature and pulse rate can take place in a hot wet climate.

Heat Effects.—The general behaviour of a cat presents a good series of changes as the rectal temperature rises:—

100 degrees F. and below.—Lies curled up.
101 degrees F.—Very drowsy.
102 degrees F.—Begins to stretch out and lie on its side.
103 degrees F.—Panting commences.
104 degrees F.—Starts licking fore-paws and front part of body.
105 degrees F.—Excessive salivation quite noticeable.
106 degrees F.—Coat dripping with saliva.
107 degrees F.—Crying and obviously in distress, but can still stand.

We did not go beyond this stage. On one occasion, when the rectal temperature remained at 106 degrees F. for four hours, sitting up to drink appeared to be too much of an effort.

SUMMARY.

Experiments are described in which male cats (one for each series of experiments) were subjected to hot atmospheres of different temperatures and humidity, for periods up to seven hours. The following observations were made and conclusions reached:—

1. Rectal temperature begins to rise above normal when the dry bulb temperature reaches 90 degrees F. When the dry bulb temperature reaches 105 degrees F. the cat is unable to tolerate an atmosphere above 65 per cent. humidity for seven hours; when it reaches 110 degrees F. it is unable to tolerate one above 35 per cent. humidity for seven hours. Respiratory rate tends to rise before the rectal temperature.
2. Progressive decrease of the relative humidity effects a definite and generally progressive reduction of the respiratory reaction to higher temperatures. Rectal temperature is correspondingly reduced only in the upper ranges of humidity.
3. Oral replacement of water lost by evaporation at high temperatures reduces the tidal and respiratory volumes, but leaves other functions unaffected.
4. The pulse rate tends to rise with the rectal temperature, in the course of a day's exposure to a hot atmosphere.
5. The cat shows only slight evidence of acclimatisation to repeated exposure to a hot wet atmosphere and none to a hot dry.
6. Tidal volume as measured by a mask is only slightly reduced with the rise of respiratory rate induced by heat.
7. The rate of water evaporation from the cat increases in general with the dry bulb temperature. In hot dry atmospheres salivation accounts for the greater part of this loss.
8. The range of variation in one individual of the different functions investigated is moderately large.
9. The cat depends upon evaporation by two methods for the regulation of its body temperature in hot environments:—(i.) Increased respiratory evaporation, which comes into action before body temperature rises; (ii.) evaporation of saliva from its coat, which is adopted when the body temperature rises to 104 degrees F. or more.

ACKNOWLEDGMENTS.

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REACTIONS OF THE DOG TO HOT ATMOSPHERES.

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(EIGHT TEXT FIGURES.)

(Read before the Royal Society of Queensland, 25th August, 1941.)

INTRODUCTION.

The dog has been a favourite animal upon which to investigate the effect of heat experimentally. Unfortunately, the obvious danger of applying the results to man have not always been recognized. Dill, Bock and Edwards (1923) drew attention to the difference between their reactions in a simple direct test. This observation does not appear to have been followed by any systematic plotting of the effects of the different atmospheric variables upon the dog, nor do the possibilities of acclimatisation appear to have been given sufficient attention. For these reasons the dog was included in our comparative experiments. There is also the important practical question of the extent to which dogs can be used by graziers in the hotter parts of Australia.

The methods of investigation were essentially those used in parallel studies upon the rabbit [Lee, Robinson and Hines (1941)]. Respiratory counts were made by sight, both with and without the mask used for respiratory volume measurements.

In the acclimatisation series Dog A was exposed daily for five and a-half days a week to the hot wet room in February-March (summer), hot dry room in May (winter), and hot wet room again in June (winter); Dog B was exposed to the hot wet room in March (autumn) and to the hot dry room from the middle of April to the middle of June.

The dogs, males of the black and tan variety common in Queensland and apparently constituting a definite breed, were kept upon a diet of raw meat and dogs' biscuits given every evening. Free water drinking was at all times permitted except during exposure to the hot atmosphere in the hydration and acclimatisation series.

More animals, more breeds, and further variations in atmospheric conditions are being studied, but the results reported here are considered to warrant interim publication.

RECTAL TEMPERATURE.

General Behaviour.—With only mild degrees of heating the rectal temperature does not rise; with intermediate degrees it rises but reaches a stable equilibrium. Only with the highest atmospheric temperature used here (110 degrees F.) did the rectal temperature fail to establish an equilibrium in the dog (B) used in the effective temperature series. (Text Figs. 1 and 4.)

Relative Effects of Temperature and Humidity.—In Table 1 are set out the average rectal temperatures exhibited by a dog exposed for seven hours to atmospheres of different compositions. The figures shown in brackets have been weighted as previously described [Yeates, Lee,

and Hines (1941)] to compensate for the reduced time of exposure in the corresponding trials. The actual time of exposure is indicated by the figures in the right-hand corner of the square. The following points will be noted:—

(i.) At a room temperature of 80 degrees F. with the highest humidities and 85 degrees F. with the intermediate and low humidities, the rectal temperature shows a tendency to rise.

(ii.) The room temperature at which the average rectal temperature shows a definite rise to 100 degrees F. or above varies with the humidity from 85 degrees F. with 95 per cent. humidity, to 100 degrees F. with 35 per cent. humidity.

(iii.) A reduction of humidity has a definite sparing effect upon the effect of hot atmospheres upon the rectal temperature. This becomes more evident as the room temperature increases above 85 degrees F., and is in general progressive.

TABLE 1.

RECTAL TEMPERATURE GRID.

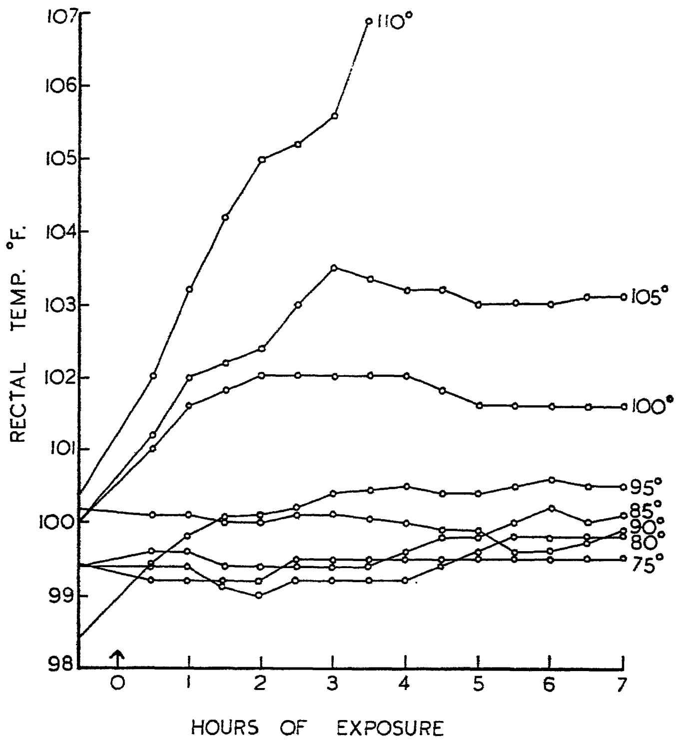
Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	99·3	99·5	99·8	100·0	100·4	102·8			
85 ..	99·5	99·3	99·8	99·8	99·9	101·6	103·9		
75 ..	99·4	99·3	99·4	99·6	100·2	101·6	102·9	[113·4] 2·0	
65 ..		99·4	99·5	99·7	100·0	100·1	101·6	102·4	[108·1] 3·5
55 ..			99·4	99·7	99·8	100·1	101·1	102·0	[105·4] 4·5
45 ..				99·8	99·7	100·2	100·4	101·2	102·9
35 ..						99·6	100·2	101·2	101·2
25 ..								100·8	100·8

The figures in each square represent the average rectal temperature in °F. during the time the dog was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed. The number below the bracket indicates the hours that the animal remained in the room.

Effect of Hydration.—In Table 2 is set out the average rectal temperature of a dog exposed to a hot dry climate (dry bulb 106 degrees F., wet bulb 80 degrees F.) and receiving on separate occasions no water, 60 ccs. per hour, and 120 ccs. per hour respectively for drinking. It will be seen that the response is definitely reduced by giving half-replacement quantities of water, and reduced a little more by increasing the water to full replacement.

Acclimatisation and Season.—In Text Fig. 2 are set out the reactions of the dog (A) repeatedly exposed to hot atmospheres. It will be seen that no acclimatisation as gauged by the rectal temperature developed in the hot wet room in summer but it did in winter. A

definite acclimatisation developed in the hot dry room in the course of the second week.



ROOM TEMP. IS SHOWN WITHIN THE GRAPH

TEXT FIGURE 1.

Reaction of a Dog's Rectal Temperature to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.)

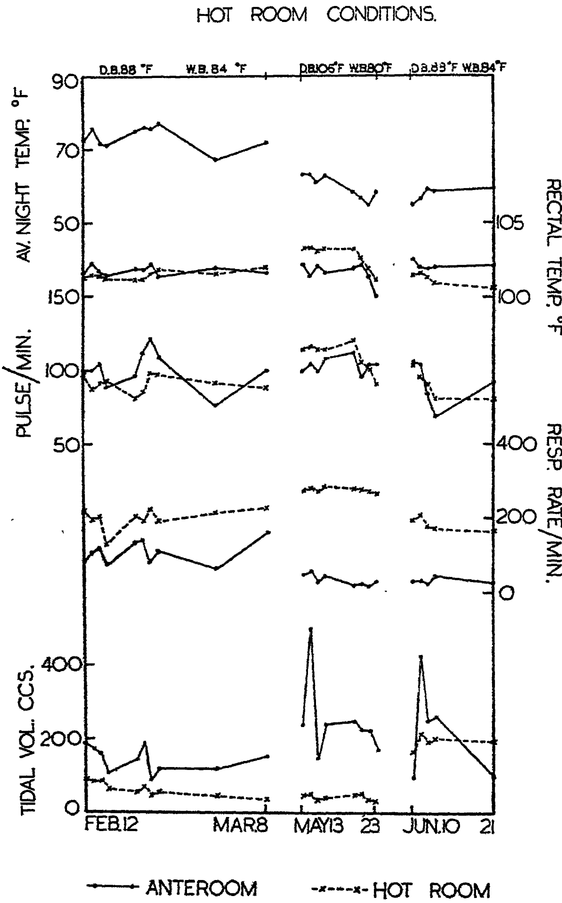
TABLE 2.

EFFECT OF THE AMOUNT OF DRINKING WATER SUPPLIED.

—	120 ml./hr.	60 ml./hr.	Nil.
Av. Rectal Temp. °F.	102·2	102·8	103·9
Av. Pulse Rate (beats/min.)	117	127	152
Av. Resp. Rate (Free) (Resp./min.) ..	232	228	242
Av. Resp. Rate (Mask) (Resp./min.) ..	110	105	167
Av. Resp. Vol. (l./min.)	7·9	8·1	6·5
Av. Tidal Vol. (mls.)	72	77	39
Av. Evap. Loss (gms./hour)	84	74	100

Dog B showed no acclimatisation in the hot wet room (autumn). In the hot dry room (autumn-winter) this dog showed a sensitivity on certain days and had to be removed before the full period had elapsed.

This sensitivity decreased in the fourth week of the serial exposures, and on this account the series was extended. Text Fig. 3 shows the maximum temperatures attained by the dog in the course of the series, and the tolerance times on the incomplete days. There appears to have occurred an increase in sensitivity rather than an acclimatisation in the first week, with the establishment of increasing acclimatisation in the fourth and successive weeks.



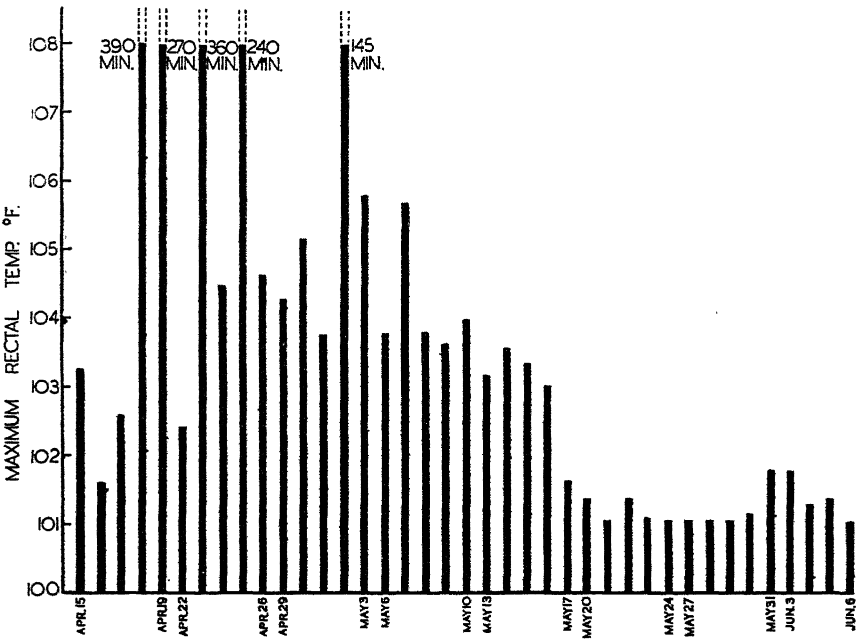
TEXT FIGURE 2.

Effects of Repeated Exposure to Hot Atmospheres upon the Reactions of a Dog. The Hot-room Figures Represent the Average Reactions on the Days in Question, Calculated as Described in the Text.

Variations in Reaction.—The following figures indicate the range of variations in rectal temperature encountered in our dogs:—

—	Ante-Room.	Av. Hot Wet Room.	4th Hour Hot Dry Room.
Dog A.—			
Summer (10 days)	101·3–102·2	101·0–101·8	..
Winter (8 days)	100·0–102·2	..	101·0–103·8
Winter (5 days)	101·9–102·5	100·5–101·5	..
Dog B.—			
Autumn (7 days)	99·4–102·5	99·5–100·3	..
Winter (10 days)	99·0–100·2	..	100·5–110·0
Winter (48 days)	98·4–101·4	..	..
Dog C.—			
Winter (8 days)	101·0–102·6	..	..

It will be seen that the range of variation in the ante-room temperature is fairly large, even in the one individual. Different individuals may differ fairly markedly in this respect. The reaction of Dog A to hot atmospheres was fairly stable, but that of Dog B inconstant. No definite seasonal effects are to be seen.



TEXT FIGURE 3.

Maximum Rectal Temperatures of a Dog on Successive Days of Exposure. (Dry Bulb, 106 degrees F.; Relative Humidity 33 per cent.). The dog was removed when its Rectal Temperature reached 108 degrees F., the Tolerance Time in these Cases is shown in the figure.

PULSE RATE.

General Behaviour.—In Text Fig. 4 the pulse rate at high temperatures will be seen to follow rather closely the curve for rectal temperature, rising with it to a plateau. At intermediate temperatures the pulse rate response is not as marked as that of rectal temperature.

Relative Effects of Temperature and Humidity.—In Table 3 is given the temperature-humidity grid in respect of pulse rate. The following points will be noticed:—

(i.) At low temperatures and at low humidities with intermediate temperatures the pulse rate tends to be somewhat higher than at intermediate temperatures and intermediate to high humidities.

(ii.) The room temperature at which the pulse rate tends to rise definitely above normal varies with the humidity from 95 degrees F. at 75 per cent. to 105 degrees F. with 25 per cent.

(iii.) A reduction of humidity has a definite sparing action upon the rise in pulse rate, where this is liable to occur, but the reduction is not uniformly progressive.

TABLE 3.

PULSE RATE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	94	87	86	81	84	105			
85 ..	96	91	86	84	84	108	104		
75 ..	91	82	81	81	82	109	109	[202]	
65 ..		90	87	80	81	82	112	94	[154]
55 ..			91	86	83	83	107	100	[115]
45 ..				88	85	86	84	102	104
35 ..						90	86	99	100
25 ..								99	96

The figures in each square represent the average pulse rate per minute during the time the dog was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.

Effect of Hydration.—Half-replacement of the water lost from the body was accompanied by a definite reduction in the average pulse rate, and full replacement was accompanied by a further small reduction (Table 2).

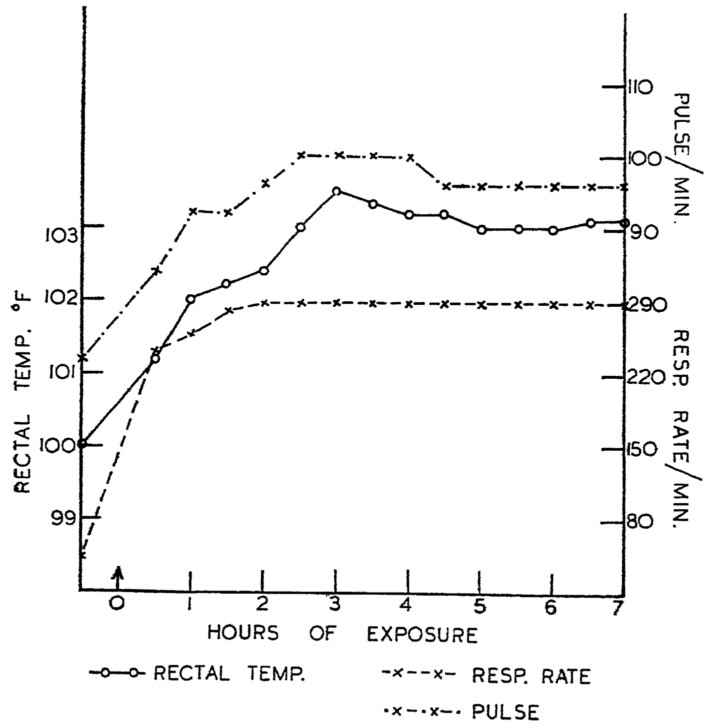
Acclimatisation and Season.—With Dog A (Text Fig. 2) no acclimatisation, as measured by the pulse rate, occurred in the hot wet room in summer, but a late acclimatisation appeared in the hot dry room. With both Dog A in winter and Dog B in autumn some reduction occurred in the hot wet room but similar reductions were to be seen in the ante-room rate. There would seem to be some other factor operating in these cases, particularly as the temperature of the room (86 degrees F.) is not such as to produce a definite rise in pulse rate. (See above.)

Variations in reaction.—The following figures indicate the range of variation in pulse rate found in our dogs:—

——	Ante-Room.	Av. Hot Wet Room.	4th Hour Hot Dry Room.
Dog A.—			
Summer (10 days)	76–120	80–98	..
Winter (8 days)	96–112	..	84–128
Winter (5 days)	68–104	80–104	..
Dog B.—			
Autumn (8 days)	52–96	47–79	..
Winter (10 days)	64–112	..	72–136
Winter (48 days)	72–112	..	..
Dog C.—			
Winter (8 days)	96–132	..	..

It will be seen that there is a fairly wide range of variation in the one individual and that the sensitivity of different individuals to heat may differ.

Correlation with Rectal Temperature.—While a fairly close correlation between rectal temperature and pulse rate (Tables 1 and 3) is seen at the higher temperatures, and throughout any one day (Text Fig. 4) the pulse is much less reactive at lower temperatures. There is some hint of a negative correlation at the lowest temperatures used here.



TEXT FIGURE 4.

Effect upon a Dog of Exposure to a Hot Atmosphere.
(Dry Bulb, 105 degrees F.; Relative Humidity, 65 per cent.)

RESPIRATORY FUNCTIONS.

General Behaviour.—The general behaviour of respiratory rate, respiratory volume, and tidal volume during exposure to heat is seen in Text Fig. 6, and the behaviour of respiratory rate at different temperatures in Text Fig. 5. It will be seen that with the lowest temperatures the rate does not change, but that with intermediate and high temperatures it rises fairly rapidly to a plateau which is thereafter maintained, even though the rectal temperature may still be rising. In this respect the dog resembles the cat rather than the rabbit. As respiratory rate rises, the volume does not rise to the same extent. It may even remain fairly constant (Text Fig. 6). The tidal volume, on the other hand, falls markedly in the early hours of exposure.

Relative Effects of Temperature and Humidity upon Respiratory Rate.—In Table 4 is given the temperature-humidity grid in respect of respiratory rate, counted without the use of a mask. It will be seen that there is a continuous rise of respiratory rate with room temperature at any one level of humidity. The temperature at which the

average rate rises definitely above normal varies from 80 degrees F. at a humidity of 95 per cent. to 90 degrees F. at a humidity of 45 per cent. The transition from a fairly low to a high rate takes place over a range of 5–10 degrees F.; with further rises in room temperature the increase is not so rapid. A reduction in humidity has a sparing action upon respiration which is, for the most part, progressive.

TABLE 4.

RESPIRATORY RATE GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	30	33	63	157	221	259			
85 ..	26	26	34	172	200	250	268		
75 ..	17	32	34	91	222	247	265	[715]	
65 ..		45	28	108	223	204	246	265	[464]
55 ..			19	94	159	203	250	263	[377]
45 ..				42	149	203	236	253	264
35 ..						157	221	261	238
25 ..								223	217

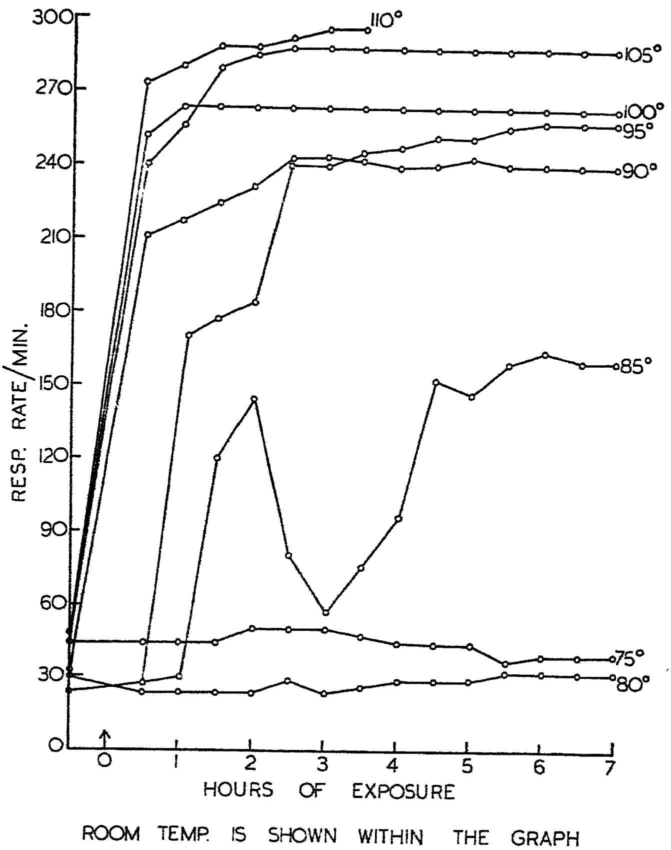
The figures in each square represent the average respiratory rate per minute during the time the dog was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.

Respiratory Rate, Respiratory Volume, and Tidal Volume.— Simultaneous observations were made in the standard hot dry (dry bulb 106 degrees F., wet bulb 80 degrees F.) and hot wet (dry bulb 88 degrees F., wet bulb 85 degrees F.) atmospheres of the respiratory rate and volume. The average values obtained were as follows:—

—	Resp. Rate (Free).		Resp. Rate (Mask).		Resp. Vol. (Mask). l/min.		Tidal Vol. (Mask). ccs.	
	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.	Ante-Room.	Av. Hot Room.
Dog A.								
Hot Wet (Summer)	105	198	43	128	5·8	6·2	135	48
Hot Dry (Winter)	30	275	19	168	4·6	7·6	242	45
Hot Wet (Winter)	26	182	18	22	4·2	4·2	234	191
Dog B.								
Hot Wet (Autumn)	115	229	49	97	6·0	10·0	123	103
Hot Dry (Winter)	30	251	19	195	4·3	9·8	233	50

The most noticeable feature here is the marked reduction of the tidal volume in the hot dry room, even when the restrictive mask is used. By this means not only is the total respiratory volume kept down but any risk of over-ventilation of the pulmonary alveoli and consequent acapnia is practically eliminated. This agrees with the observations of Hemingway (1938a) upon mask-free dogs with lower degrees of heating.

The use of a mask markedly restricts the respiratory rate in the ante-room and usually in the hot wet room, but not so markedly in the hot dry room.



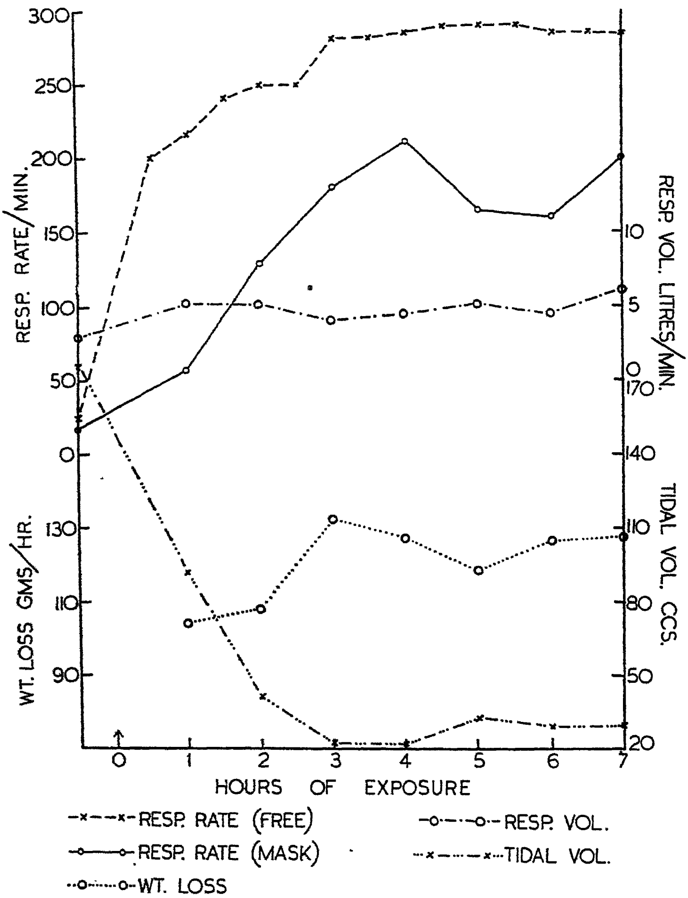
TEXT FIGURE 5.

Reaction of the Respiratory Rate of a Dog to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

Effects of Hydration.—From Table 2 it will be seen that varying the amount of drinking water from nil to full replacement is not accompanied by any appreciable change in the free respiratory rate, but a reduction in the mask rate does occur when half replacement water is given. With the reduction in rate goes an actual increase in respiratory volume, this reverse change being brought about by a marked increase in tidal volume. It would appear that in states of dehydration more strain is thrown upon the respiratory mechanism, in maintaining some sort of heat regulation, and that this is met, not by increasing total volume, but by increasing the rate with a reduction in depth which is more than compensatory. In view of the large variability in respiratory reaction shown by even the one individual, these results should be treated with caution at this stage.

Acclimatisation and Season.—Respiratory rates show some progressive reduction with repeated exposure in the hot wet room in winter

with Dog A, but not elsewhere. The tidal volume shows some progressive reduction in the hot wet room in summer with Dog A, but with this goes an increase in mask rates. These changes are probably not indicative of a true acclimatisation.



TEXT FIGURE 6.

Typical Reactions of Respiratory Functions and Evaporative Loss in a Dog. (Dry Bulb, 106 degrees F.; Relative Humidity, 33 per cent.).

Season, on the other hand, appears to have a definite effect upon the ante-room values of respiratory functions, as is shown in the following table:—

—	Resp. Rate (Free).		Resp. Rate (Mask).		Resp. Vol. (Mask). l/min.		Tidal Vol. (Mask). ccs.	
	Rate.	Av. Dev.	Rate.	Av. Dev.	Av.	Av. Dev.	Av.	Av. Dev.
Dog A.								
Summer (10 days)	105	25·6	43	12·8	5·8	1·5	135	29·7
Winter (8 days) ..	30	9·8	19	3·8	4·6	1·1	242	58·0
Winter (5 days) ..	26	5·2	18	2·0	4·2	1·4	234	100·2
Dog B.								
Autumn (8 days)	115	48·7	49	28·7	6·0	1·2	123	29·1
Winter (10 days)	30	4·4	20	2·0	4·2	0·6	210	40·2

The winter reactions as compared with the summer and autumn reactions are characterised by markedly reduced rates, slightly reduced respiratory volumes, and definitely increased tidal volumes.

Variations in Reactions.—The following figures indicate the extremes of variation in the reactions of three dogs:—

	—	Dog A. (Summer) 10 days.	Dog A. (Winter) 13 days.	Dog B. (Autumn) 8 days.	Dog B. (Winter) 10 days.	Dog C. (Winter) 8 days.
Ante-Room.	Resp. Rate (Free) ..	60–160	16–48	44–184	24–40	28–32
	Resp. Rate (Mask)	20–92	16–32	24–112	16–28	16–32
	Resp. Vol. (Mask) ..	4·0–8·4	2·0–8·0	4·0–8·4	3·2–6·0	3·2–4·8
	Tidal Vol. (Mask) ..	91–189	100–500	71–229	143–300	100–240
†Hot Wet Room.	Resp. Rate (Free) ..	126–229	161–204	205–246	..	..
	Resp. Rate (Mask)	65–196	19–26	61–176	..	..
	Resp. Vol. (Mask) ..	5·1–7·6	3·8–5·0	9·0–11·4	..	..
	Tidal Vol. (Mask) ..	38–88	165–208	51–161	..	..
† Hot Dry Room.	Resp. Rate (Free) ..	..	265–282	..	229–260*	..
	Resp. Rate (Mask)	..	157–206	..	168–231*	..
	Resp. Vol. (Mask) ..	..	4·9–8·8	..	7·0–14·6*	..
	Tidal Vol. (Mask) ..	..	31–47	..	37–74*	..

* 7 completed days for Dog B in hot dry room.
† Hot room figures are averages for the period of exposure.

It will be seen that in the ante-room the range of variation in respiratory rate is great in summer and autumn, but less in winter, the variation in respiratory volume is moderate, and that in tidal volume is fairly large. The variability in the hot wet room in all items is large, but the range is reduced in the hot dry room.

Different individuals do not differ markedly in the ante-room reactions, but Dog B tended to be more sensitive than Dog A in the hot room (these figures apply to the period before acclimatisation was established).

Correlation with Body Temperature.—Comparison of the temperature-humidity grids for respiratory rate and rectal temperature (Tables 1 and 4) and the graphs of the same functions (Text Figs. 1, 4, and 5) indicate a fairly close correlation, but it will be seen that the respiratory rate tends to rise at somewhat lower room temperatures, to rise more rapidly in the course of an exposure, and to reach an equilibrium when the rectal temperature is still rising.

Open-mouthed panting occurs in the neighbourhood of 100 degrees F.—a much lower temperature than in any other animal hitherto studied by us.

EVAPORATION OF WATER.

General Behaviour.—With moderate and intermediate room temperatures the rate of evaporative loss rises fairly rapidly in the early part of the exposure to a plateau which is maintained for the rest of the exposure (Text Fig. 6). At very high temperatures (with low humidities) it rises continuously throughout the exposure. Absorption of water by the coat in humid atmospheres was not apparent.

Relative Effects of Temperature and Humidity.—In Table 5 is given the temperature-humidity grid in respect of evaporative loss. It will be seen that in general the rate of evaporation increases with the dry bulb temperature throughout. At 95 degrees F. and above a reduction of humidity is accompanied by a reduction in evaporative loss

which tends to be progressive. Below this temperature humidity has no constant effect.

TABLE 5.

EVAPORATIVE LOSS GRID.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	9	12	19	29	39	86			
85 ..	12	11	16	23	39	59	98		
75 ..	12	14	14	25	38	69	85		
65 ..		19	14	20	48	48	79	119	[221]
55 ..			13	25	30	52	74	103	[140]
45 ..				24	36	50	67	93	150
35 ..						39	64	109	121
25 ..								100	100

The figures in each square represent the average evaporative loss in grams per hour during the time the dog was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 °F. before 7 hours had elapsed.

Effect of Hydration.—In Table 2 it will be seen that some reduction occurred in evaporative loss when half replacement water was given, but this reduction was not so marked with full replacement. This effect, if the differences are to be regarded as significant, is not easy to explain.

Correlation with Respiration.—If the temperature-humidity grids for respiratory rate and evaporative loss (Tables 4 and 5) are compared, it will be seen that the correlation is good as regards dry bulb temperature, but the effect of humidity is much less marked upon the evaporation. This may represent a compromise between reduced respiratory rate and increased rate of evaporation from mucous membrane. That the evaporative loss is not due entirely to respiratory activity is indicated by the fact that the curve for evaporation may continue to rise after respiratory rate has attained a steady value.

Evaporation from the respiratory mucous membrane into the tidal air may account for much of the observed weight loss in hot wet atmospheres, but it is insufficient to account for the observed loss in a hot dry atmosphere, as is shown by the following figures:—

—	Water Content of Inspired Air. (gms./l.)	Water Content of Expired Air. (gms./l.)	Av. Resp. Vol. (l/hr.)	Av. Water Loss. (gms./hr.)	
				Calc.	Obs.
Hot Wet—					
Dog A	0·027	0·046	372	7	38
Dog B	0·027	0·046	600	10	30
Hot Dry—					
Dog A	0·015	0·048	456	15	120
Dog B	0·015	0·048	613	20	118

These figures relate to mask breathing, but even if the same tidal volume is preserved with free respiratory rates, the calculated water loss in the hot dry atmosphere would only be about 30 gms. per hour.

POWERS OF HEAT REGULATION.

Comparable Atmospheric Conditions.—In Text Fig. 7 the results of Tables 1, 3, and 4 are set out in graphic form. From them it will be seen that both temperature and humidity are important factors in determining the effect of an atmosphere upon the dog. The effect of humidity is greater upon the dog than upon the fowl [Yeates, Lee, and Hines (1941)], rabbit, pig [Robinson and Lee (1941a)], or cat [Robinson and Lee (1941b)].

Critical Temperatures.—At a room temperature of 80 to 85 degrees F. evidence begins to appear of a disturbance in the dog's equilibrium. The critical temperature tends to be higher at the lower humidities.

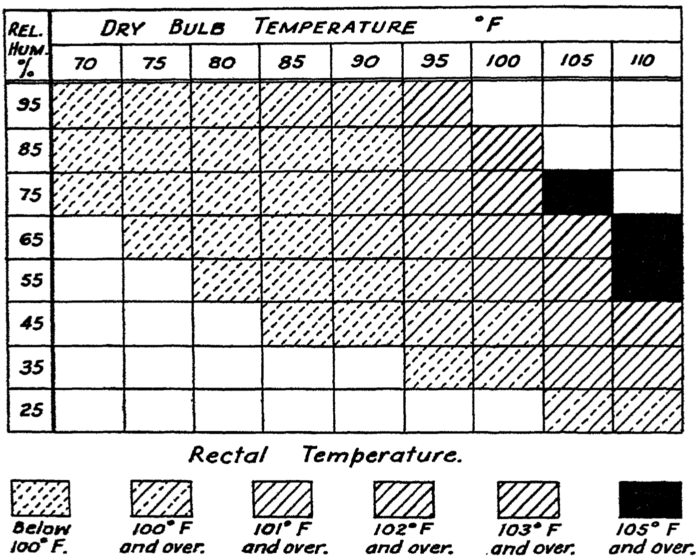
Open-mouthed panting makes its appearance at quite a low rectal temperature (100 degrees F.), one which is almost within the normal range. This is in agreement with Hemingway's observations (1938b).

In the dog we have repeatedly observed that a body temperature of 105 degrees F. is a critical one. If a further rise occurs, the animal's equilibrium breaks down with increasing speed and hyperpyrexia develops with extraordinary rapidity. If, however, the animal manages to remain in equilibrium at this temperature for some time, the temperature not infrequently falls again, even to quite moderate figures. The factors which determine whether an animal tending to come into equilibrium at this level shall succeed or pass over into rapid breakdown appear to be trivial and inconstant. Barking and excitement are often associated with the failure to establish equilibrium, but whether as cause or effect is not clear.

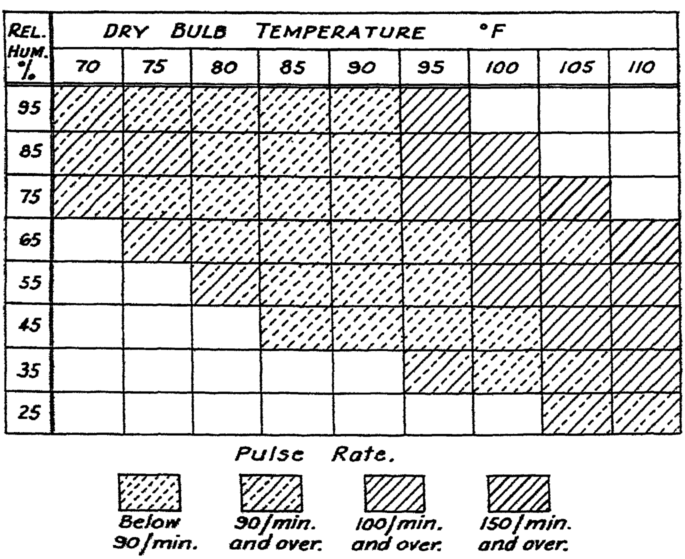
At a rectal temperature of 109 degrees F. the dog develops "staggers," affecting mainly the hind limbs and shows signs of imminent collapse. A rectal temperature of 111 degrees F. was attained by accident upon one occasion, but was rapidly reduced by our usual method of hosing.

The dog used in the effective temperature series was able to tolerate atmospheres of 105 degrees F. provided the humidity did not exceed 65 per cent., and atmospheres of 110 degrees F. provided the humidity did not exceed 45 per cent. Before it became acclimatised, however, it was upon occasions unable to tolerate an atmosphere of 106 degrees F. and 33 per cent. humidity. In all these respects it should be pointed out that the dog has proved more easily influenced in its behaviour by adventitious influences than any other animals we have studied, and more individual in its reactions.

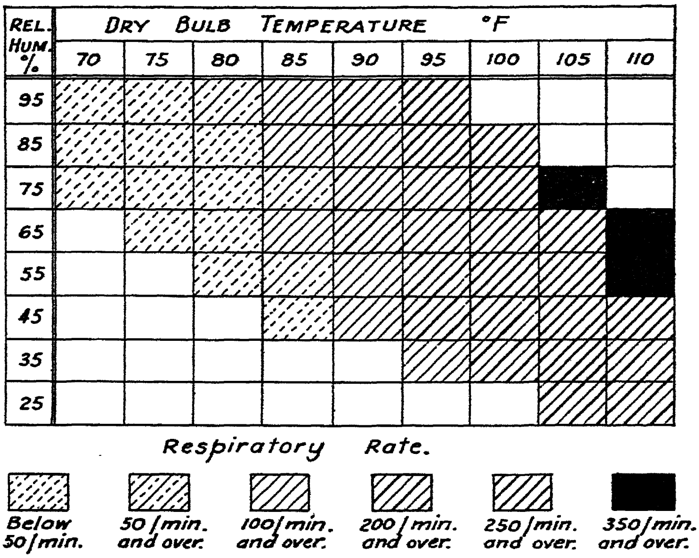
Methods of Heat Regulation.—The hair of the breed of dog used here is short. Interference with heat exchange by radiation and conduction from the general skin surface should not, therefore, suffer as much interference as in the rabbit and cat, although there should be more restriction than in the pig. The response of the cardio-vascular system to heat would help in any exchanges by these channels. Hemmingway (1938b) has drawn attention to the importance of the ears in this respect.



Rectal Temperature.



Pulse Rate.



TEXT FIGURE 7.

Diagrammatic Representation of the Comparative Effects of Temperature and Humidity upon the Reactions of the Dog.

The use of the respiratory mechanism has long been postulated as the chief method of heat regulation of the dog. That this mechanism is important is borne out by the low body temperature at which panting takes place, and the rapid rise of respiratory rate with room temperature. In the hot wet room it could very well account for the greater proportion of evaporative loss. In the hot dry room, however, the volume of air actually respired is not sufficiently large to account for more than a part of the observed evaporative loss, and the curves of respiratory volume and weight loss do not run parallel.

While it is true that some saliva is lost by dripping from the tongue, the amount is not great enough to account entirely for the discrepancy. There are two remaining possibilities:—(i.) Evaporation of saliva from the tongue, nose, and lips into air which, while not forming part of the true tidal air, does pass over these areas, either by convection currents or by the movements of the head and tongue which accompany panting and licking. (ii.) True insensible perspiration from the general skin surface. The few sweat glands of the paws are probably of little importance for heat regulation.

By the marked reduction of tidal volume the risk of acapnia is almost entirely obviated in the dog. Even when water is withheld, the respiratory volume is not increased, although the rate rises. In this respect it differs from the cat.

Acclimatisation.—Much more definite evidence of acclimatisation was obtained on the dog than upon any other animal studied hitherto. This occurred to hot dry room exposures in both dogs, and to hot wet

room exposures in one series in one of them. After acclimatisation had been established, the reactions remained very constant.

Heat Effects.—When the body temperature is below 100 degrees F. the dog lies quietly curled up in its cage, and tends to sleep. When it reaches 100 degrees F. the type of respiration changes to open-mouthed panting, although the rise in rate is as yet only moderate. At a rectal temperature of 102 degrees F. salivation becomes marked and the typical drooling tongue hangs out of the side of the mouth. As the temperature rises further the animal becomes restless, barks a great deal, and drinks water avidly. At a rectal temperature of 105 degrees F. the animal reaches a crisis. It is extremely excitable, and bites its cage. From this point it may gradually settle down again, or pass over into a rapidly developing hyperpyrexia. At 107 degrees F. the dog is noticeably distressed and its hindquarters show some weakness. At 109 degrees F. typical "staggers" develops, and the tongue is cyanotic. There is incoordination of the limbs, particularly the hind limbs. These tend to collapse, or, if the animal does manage to retain its feet, it is quite unable to steer a straight course. The abdomen appears swollen, probably as a result of aerophagy. While we have had convulsions develop in other dogs, none were seen in the dogs used in this series. A rectal temperature of 111 degrees F. was obtained upon one occasion, but the duration was very short. Hosing rapidly checks the hyperpyrexia, and recovery has on every occasion been complete. Both dogs are in splendid condition, and show no fear or dislike for the experiments.

SUMMARY.

Experiments are described in which two "black and tan," short-haired, male dogs were subjected to hot atmospheres of different temperatures and humidity for periods up to seven hours. The following observations were made and conclusions reached:—

1. Rectal temperature shows a tendency to rise above normal with a room temperature of 80 to 85 degrees F., depending upon the humidity. A reduction of humidity has a definite sparing effect which becomes more evident as the room temperature rises above 85 degrees F., and is in general progressive.

2. The pulse rate tends to rise definitely above normal at a room temperature which varies from 95 degrees F. at 75 per cent. relative humidity to 105 degrees F. at 25 per cent.

3. The respiratory rate rises continuously with room temperature over the whole range 75 degrees F. to 110 degrees F. It rises definitely above normal at a room temperature which varies from 80 degrees F. at 95 per cent. relative humidity to 90 degrees F. at 45 per cent.

4. As the respiratory rate rises with exposure to heat the tidal volume is markedly reduced, reaching, in the hot dry atmosphere, a

fifth of the normal value. The respiratory volume is not greatly increased.

5. The rate of water evaporation from the dog rises with the dry bulb temperature, but is not much affected by the humidity until a room temperature of 95 degrees F. is reached, above which reduced humidity is accompanied by reduced evaporative loss.

6. Oral replacement of half the water lost by evaporation at high temperatures is accompanied by a reduction in body temperature, pulse rate, respiratory rate (as measured with the mask), and evaporative loss, and an increase in respiratory and tidal volumes. Full replacement is accompanied by a slight further reduction in temperature.

7. Repeated exposure to a hot wet atmosphere resulted in an acclimatisation in one series as judged by the rectal temperature, pulse rate, and respiratory reaction. More marked acclimatisation occurred in both dogs to the hot dry room.

8. While evaporation shows a definite relationship to respiratory functions, this is not complete. In the hot dry room the respiratory volume alone could not account for the observed weight loss.

9. The dog after acclimatisation is unable to tolerate for seven hours an atmosphere of 105 degrees F. with a relative humidity of 75 per cent. or one of 110 degrees F. with a relative humidity of 55 per cent.

10. Open-mouthed panting occurs at the low body temperature of 100 degrees F. Respiratory reactions occur early in the dog and serve to protect it against moderately hot atmospheres, especially hot wet atmospheres. This mechanism has to be supplemented by salivary evaporation to surrounding air with higher temperatures, and probably also by increased insensible evaporation from the body surface.

11. At a rectal temperature of 105 degrees F. the dog faces a crisis. If equilibrium is not established, hyperpyrexia rapidly develops with marked excitability. At 109 degrees F. "staggers" develops, affecting mainly the hind limbs. Recovery from hyperpyrexia can be obtained by hosing.

12. The range of variation in one individual of the various reactions investigated is fairly large, especially before acclimatisation. Individuals may differ fairly markedly in their reactions.

ACKNOWLEDGMENTS.

The investigations here reported were carried out under the Commonwealth Research Projects Scheme for Universities, financed by the Commonwealth Government, through the Council for Scientific and Industrial Research. Valuable assistance and advice were received from officers of the University Departments of Veterinary Science and Biology, and the State Department of Agriculture and Stock.

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REACTIONS OF THE SHEEP TO HOT ATMOSPHERES.

By DOUGLAS H. K. LEE, M.Sc., M.D., D.T.M., and KATHLEEN ROBINSON, M.Sc., Department of Physiology, University of Queensland.

5 TEXT FIGURES.

(*Read before the Royal Society of Queensland, 25th August, 1941.*)

INTRODUCTION.

While the energy metabolism and nutrition of the sheep have been subjected to considerable investigation, the reactions of this animal to hot atmospheres appear to have been almost entirely neglected. Yet such reactions must be of importance to a country which is largely tropical or sub-tropical, and which is, at the same time, one of the leading wool-producing countries of the world. A very little investigation reveals that this animal's reactions to heat are extraordinarily interesting. Their closer study should be very important to comparative physiology.

The methods of investigation used in these studies were essentially those described in connection with the rabbit [Lee, Robinson, and Hines (1941)]. Respiratory counts were made by sight, both with and without the mask used for respiratory volume measurements.

In the acclimatisation series two animals were exposed daily for five and a-half days a week for varying periods:—Sheep A for four weeks to the hot wet room in February (summer), for four weeks to the hot dry room in April (autumn), and for two weeks to the hot wet room in June (winter); Sheep B for two weeks to the hot wet room in March (autumn), the hot dry room in May (winter), and the hot dry room in June (winter).

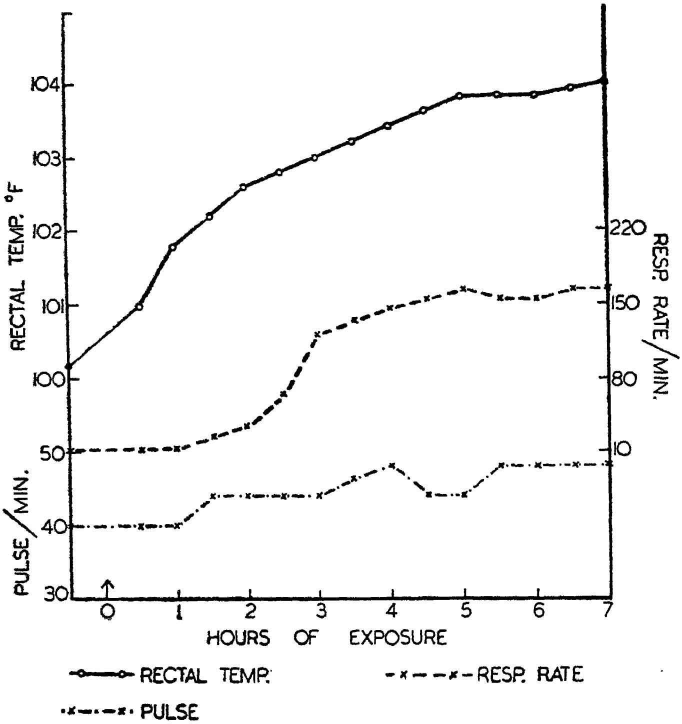
The sheep, merino wethers, were kept upon a diet of lucerne hay given every evening. Free water drinking was at all times permitted, except during exposure to the hot atmosphere in the hydration and acclimatisation series. More animals, more breeds, and further variations in atmospheric conditions are being studied, but the results reported here are considered to warrant interim publication.

RECTAL TEMPERATURE.

General Behaviour.—On exposure to moderately hot atmospheres the rectal temperature (Fig. 1) rises gradually throughout the period, with some tendency to progress to an equilibrium. With the highest degrees of heating no equilibrium is established, but the rate of rise is much slower than with any of the domestic animals previously studied by us (Fig. 2).

Relative Effects of Temperature and Humidity.—Table 1 presents a temperature-humidity grid showing the average rectal temperature exhibited by a sheep when exposed for seven hours to atmospheres of different composition. Inspection shows the following points:—

(1) Below a dry bulb of 90 degrees F. neither temperature nor humidity produces any definite effect upon rectal temperatures.



TEXT FIGURE 1.

Effect upon a Sheep of Exposure to a Hot Atmosphere. (Dry Bulb, 105 degrees F.; Relative Humidity, 45 per cent.)

TABLE 1.

Rectal Temperature Grid

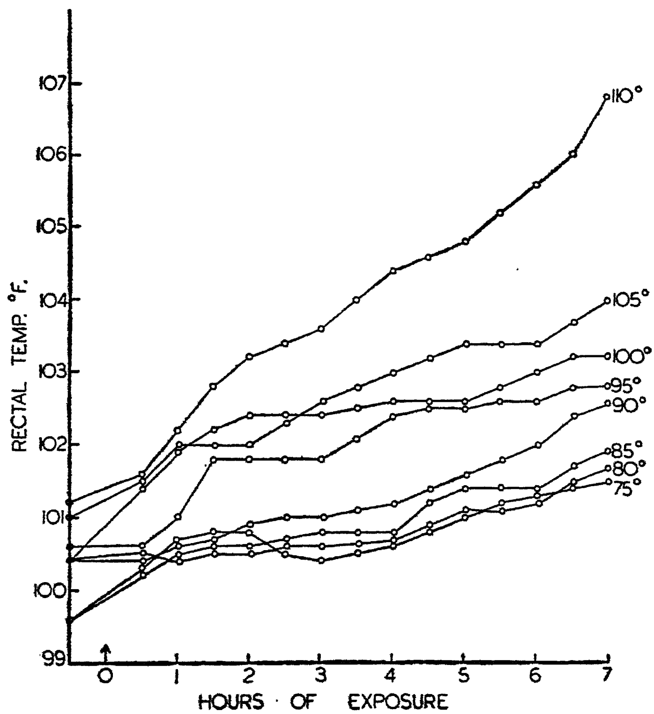
Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	100·2	100·7	101·0	101·2	101·6	102·7	..	..	..
85 ..	100·6	100·6	100·7	100·8	101·6	102·2	103·5	..	..
75 ..	101·1	100·6	100·7	101·3	101·6	101·5	103·3	[104·5] 6·8	..
65 ..	..	100·9	100·9	100·9	101·3	101·6	102·4	102·7	104·0
55 ..	..	..	..	101·3	102·1	102·0	101·9	102·7	103·7
45 ..	..	..	..	101·6	101·7	101·9	101·9	102·8	102·8
35 ..	..	..	..	..	..	102·2	101·9	102·0	101·9
25 ..	..	..	..	..	..	..	..	102·1	103·0

The figures in each square represent the average rectal temperature in degrees F. during the time the sheep was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before 7 hours had elapsed. The number below the bracket indicates the hours that the animal remained in the room.

(2) At 90 degrees F. definite rises of rectal temperature are obtained with all humidities, and above this temperature there is a rise in reaction with rise in dry bulb.

(3) Only at 105 degrees F. with 75 per cent. humidity was the sheep unable to tolerate the conditions for seven hours, and even then it failed by only a very small margin.

(4) There is some indication of an effect by humidity at 95 degrees F. At higher temperatures a reduction of humidity appears to have a definite sparing action.



ROOM TEMP. IS SHOWN WITHIN THE GRAPH

TEXT FIGURE 2.

Reaction of a Sheep's Rectal Temperature to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

Effect of Hydration.—In Table 2 is given the average rectal temperature of a sheep exposed to a hot dry atmosphere (dry bulb 106 degrees F., wet bulb 80 degrees F.), and given by oral administration on separate occasions, no water, 70 ccs. per hour and 140 ccs. per hour respectively. It will be seen that the average rectal temperature was reduced slightly by giving water equal to half that lost by evaporation, and rather more definitely by increasing the water supply to full replacement. The differences are not great, however.

TABLE 2.

Effect of the Amount of Drinking Water Supplied.

—	140 ml/hr.	70 ml/hr.	Nil.
Rectal Temp. °F.	102·2	102·6	102·8
Pulse Rate (beats/min.)	55	64	55
Resp. Rate (Free)	74	103	89
Resp. Rate (Mask) .. .. (Resp./min.)	45	73	44
Resp. Vol. (litres/min.)	5·6	7·5	5·9
Tidal Vol. (mls.)	124	103	134

Acclimatisation and Season.—There was no definite evidence of an acclimatisation to either hot wet or hot dry atmospheres with either animal. The season of the year had some effect on ante-room temperatures, which tend to be lower in late winter. (*See* below.) No difference between summer and winter, however, is seen in the sheep's reactions to a hot wet atmosphere.

Variations in Reaction.—The following figures indicate the range of variation in rectal temperature encountered in our sheep:—

—	Ante-room.	Av. Hot Wet Room.	Av. Hot Dry Room.
Sheep A—			
Summer (10 days)	101·7–103·4	102·3–103·3	..
Autumn (10 days)	101·9–102·8	..	102·2–103·0
Winter (5 days)	101·7–103·1	102·4–102·8	..
Late Winter (48 days)	99·4–102·6	..	..
Sheep B—			
Autumn (8 days)	102·5–103·3	102·4–103·6	..
Winter (8 days)	101·2–102·8	..	102·1–103·1
Winter (8 days) (shorn) ..	101·1–102·9	..	102·1–103·3
Sheep C—			
Spring (5 days)	101·8–104·3	..	..

It will be seen that the range of ante-room rectal temperatures in any one individual sheep is fairly wide, but that between different sheep may not be great. The range of reactions in the hot room is only moderate.

PULSE RATE.

General Behaviour.—The sheep often shows a moderate but definite response to high temperatures in its pulse rate (Fig. 1). At milder temperatures the pulse remains constant throughout the period or may fall slightly.

Relative Effects on Temperature and Humidity.—In Table 3 is given the temperature-humidity grid in respect of pulse rate. While there is some general tendency for a high average pulse rate at high temperatures, there is considerable variation from day to day.

TABLE 3.
Pulse Rate Grid.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	35	36	39	40	36	44	..	..	..
85 ..	37	36	40	40	38	50	50	..	..
75 ..	50	44	44	36	42	47	50	[61]	..
65 ..	..	47	51	43	41	40	46	45	44
55 ..	..	..	53	48	44	47	50	45	52
45 ..	..	..	..	52	52	50	41	44	40
35 ..	..	..	..	..	..	53	43	41	53
25 ..	..	..	..	..	..	..	..	53	59

The figures in each square represent the average pulse rate per minute during the time the sheep was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before 7 hours had elapsed.

Effect of Hydration.—Variations in the supply of water produced no significant differences in pulse rate (Table 2).

Acclimatisation and Season.—Repeated exposures to either hot wet or hot dry atmospheres produced no reduction in average pulse rate.

The ante-room pulse rate tends to be higher in early winter than in summer, but it returns to its previous values in late winter. (*See* below.) The pulse rate in the hot wet room in early winter tends to be higher than in summer or autumn.

Variations in Reaction.—The following figures indicate the range of variation in pulse rates encountered in our sheep:—

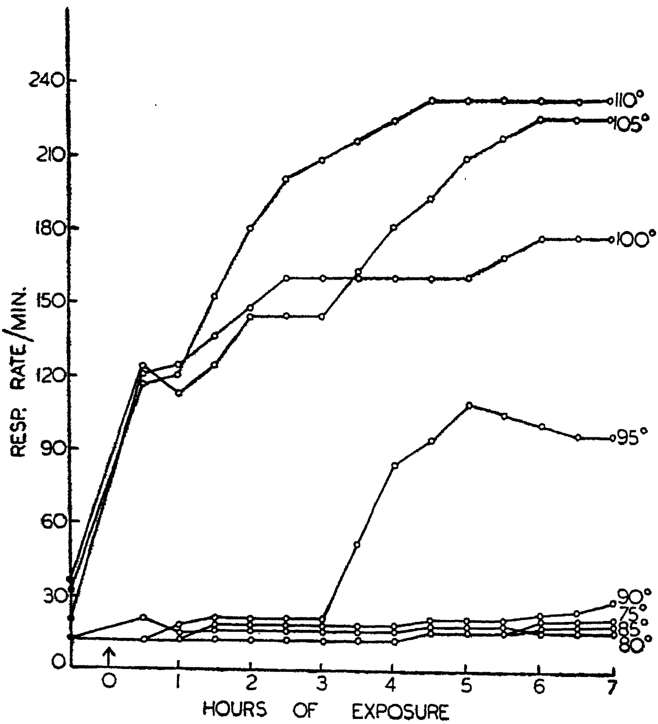
——	Ante-room.	Av. Hot Wet Room.	Av. Hot Dry Room.
Sheep A—			
Summer (10 days)	44–56	41–53	..
Autumn (10 days)	44–60	..	41–52
Winter (5 days)	54–88	44–62	..
Late Winter (48 days)	36–68	..	..
Sheep B—			
Autumn (8 days)	56–88	54–60	..
Winter (8 days)	56–104	..	53–66
Winter (8 days) (shorn) ..	68–108	..	66–81
Sheep C—			
Spring (5 days)	64–92	..	..

The figures show a fairly large variation in the one animal and also between different individuals.

Correlation with Rectal Temperature.—When the pulse rate rises it does so in association with the rectal temperature (Fig. 1), but it is generally much less reactive.

RESPIRATORY FUNCTIONS.

General Behaviour.—The general behaviour of respiratory rate during exposure to hot atmospheres is shown in Figs. 1 and 3. It will be seen that with the higher temperatures there is a gradual rise in rate to a plateau, even in the severest temperatures. The rate of rise is far less rapid than with any of the other animals previously studied by us.



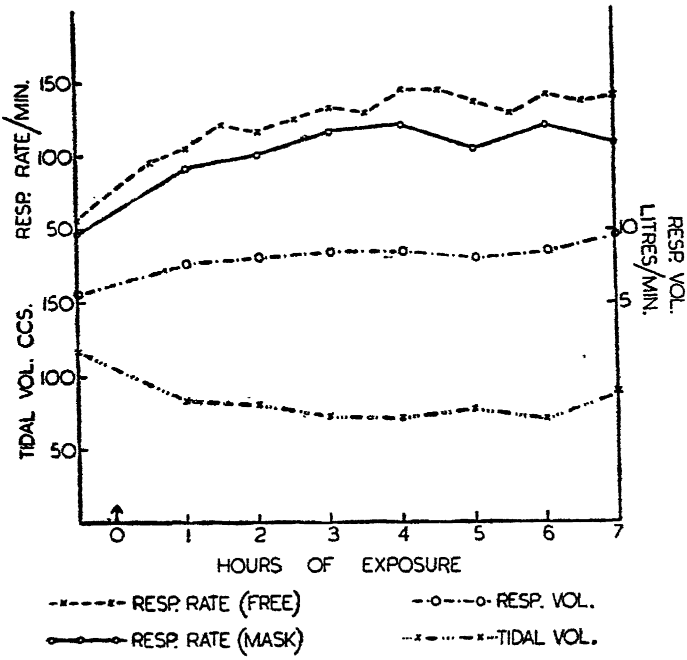
TEXT FIGURE 3.

Reaction of the Respiratory Rate of a Sheep to Hot Atmospheres of Different Temperatures but the same Relative Humidity (65 per cent.).

Typical reactions for respiratory rate, respiratory volume, and tidal volume are shown in Fig. 4. As the respiratory rate rises, so does the respiratory volume, but not quite to the same extent, as the tidal volume falls somewhat. (However, *see* table below.)

Relative Effects of Temperature and Humidity upon Respiratory Rate.—In Table 4 is given the temperature-humidity grid in respect of respiratory rate counted without the use of the mask.

The first noticeable rise appears at a room temperature of 85 degrees F. with the highest humidity. This critical temperature rises to 95 degrees F. with a relative humidity of 35 per cent. At all temperatures producing a rise in respiratory rate, with the exception of the highest humidity, a progressive reduction in humidity is accompanied by a generally progressive reduction in respiratory rate.



TEXT FIGURE 4.

Typical Reaction of Respiratory Functions in the Sheep. (Dry Bulb, 106 degrees F.; Relative Humidity, 33 per cent.)

TABLE 4.

Respiratory Rate Grid.

Rel. Hum. %	Dry Bulb Temperature °F.								
	70	75	80	85	90	95	100	105	110
95 ..	12	12	15	27	28	119	..	..	..
85 ..	9	12	12	18	70	157	181	..	..
75 ..	16	12	12	12	31	135	179	[209]	..
65 ..	..	15	16	14	15	25	146	165	186
55 ..	..	..	15	13	15	57	131	163	187
45 ..	..	..	..	12	13	61	60	97	139
35 ..	..	..	..	..	..	30	56	66	97
25 ..	..	..	..	..	..	..	..	88	108

The figures in each square represent the average respiratory rate per minute during the time the sheep was exposed to the particular atmospheric conditions. Figures in square brackets have been weighted as described in the text as the animal had to be removed with a rectal temperature of 107 degrees F. before 7 hours had elapsed.

Respiratory Rate, Respiratory Volume, and Tidal Volume.—Simultaneous observations of respiratory rate and volume were made in standard hot wet (dry bulb 88 degrees F., wet bulb 85 degrees F.) and hot dry (dry bulb 106 degrees F., wet bulb 80 degrees F.) conditions. The values obtained are given in the following table:—

—	Resp. Rate (free).		Resp. Rate (mask).		Resp. Vol. (mask) 1/min.		Tidal Vol. (mask) ccs.	
	Ante-room.	Av. Hot Room.	Ante-room.	Av. Hot Room.	Ante-room.	Av. Hot Room.	Ante-room.	Av. Hot Room.
Sheep A—								
Hot Wet (Summer) ..	67	109	61	90	6·1	8·2	100	91
Hot Dry (Autumn) ..	78	136	58	108	4·8	9·5	83	88
Hot Wet (Winter) ..	57	141	48	123	2·3	9·0	48	74
Sheep B—								
Hot Wet (Autumn) ..	57	126	33	69	3·7	7·4	116	107
Hot Dry (Winter) ..	47	128	34	102	3·8	9·3	110	91
Hot Dry (Winter shorn)	21	116	19	98	1·9	8·2	100	84

It will be seen that the rate is not increased as markedly as with the other animals, and tidal volume is not greatly altered. The use of the mask does not have a great repressive effect.

Effect of Hydration.—Alterations in the supply of drinking water were not accompanied by regular effects upon the respiratory rate, volume, or tidal volume (Table 2).

Acclimatisation and Season.—No definite seasonal variations in respiratory rate were detected, either in the ante-room or in the hot wet room, but the respiratory volume tended to be lower in winter than in autumn in the ante-room. (*See* tables above and below.) No evidence of acclimatisation was obtained.

Variations in Reaction.—The following figures indicate the extremes of variation in the ante-room and hot room values of the respiratory functions in sheep:—

	—	Sheep A. (Summer) 10 days.	Sheep A. (Autumn) 10 days.	Sheep A. (Winter) 5 days.	Sheep B. (Autumn) 8 days.	Sheep B. (Winter) 8 days.	Sheep B. (Winter Shorn) 8 days.
Ante-room	Resp. Rate (Free) ..	40–112	40–108	24–84	40–72	36–56	20–24
	Resp. Rate (Mask) ..	40–104	36–76	16–72	24–44	24–48	16–20
	Resp. Vol. (Mask) 1/min.	2·4–10·8	2·4–8·4	1·6–3·2	3·2–4·4	2·0–8·0	1·2–2·8
	Tidal Vol. ccs. ..	50–159	40–140	36–100	82–157	56–222	75–140
Hot Wet Room	Resp. Rate (Free) ..	77–154	..	128–161	112–139	..	..
	Resp. Rate (Mask) ..	62–131	..	105–141	59–83	..	..
	Resp. Vol. (Mask) 1/min.	4·6–12·7	..	7·7–10·1	6·2–8·6	..	..
	Tidal Vol. ccs. ..	66–112	..	62–86	100–115	..	..
Hot Dry Room	Resp. Rate (Free) ..	..	120–159	..	..	112–145	99–132
	Resp. Rate (Mask) ..	..	98–118	..	..	77–134	87–131
	Resp. Vol. (Mask) 1/min.	..	7·9–11·9	..	..	7·0–11·9	6·2–10·3
	Tidal Vol. ccs. ..	..	77–106	..	..	74–104	67–101

The ranges are quite large in the ante-room, but not so great in the hot room.

Correlation with Body Temperature.—Temperature-humidity grids for rectal temperature and respiratory rate (Tables 1 and 4) and curves of Figs. 1, 2, and 3 show a certain degree of correlation between the two reactions. When a high rate is demanded, the rise is at first more rapid than that of rectal temperature, but it reaches a plateau more readily. Panting in the merino with the mouth slightly open occurs only when the rectal temperature is very high, in the vicinity of 106 degrees F.

EVAPORATION OF WATER.

While it has been possible to establish the order of evaporative water loss from the sheep in the hot wet atmosphere as 50 gms./hr. in the hot wet room and 62 gms./hr. in the hot dry room, the variability in the water content of the wool has, so far, prevented our making more detailed comparisons. For this purpose a second air-conditioning room is required in which to keep the experimental animal under a constant humidity between trials.

That water is evaporated by routes other than the expired air is indicated by the calculation that in the atmospheres mentioned above, the maximum amounts of water that could be evaporated into the observed volume of air respired are 11 gms. and 20 gms./hr. respectively. That this evaporation is not merely that of water stored in the fleece is indicated by the fact that the same animal after shearing lost 69 gms./hr. in the hot dry atmosphere.

POWERS OF HEAT REGULATION.

Comparable Atmospheric Conditions.—In Fig. 5 the results of Tables 1 and 4 are expressed in graphic form. It will be seen from this that both temperature and humidity play important parts in determining the reactions of the sheep. The effect of humidity is quite considerable, showing a closer resemblance to that of man [Yeates, Lee, and Hines (1941)] and the dog [Robinson and Lee (1941)] than to the other animals.

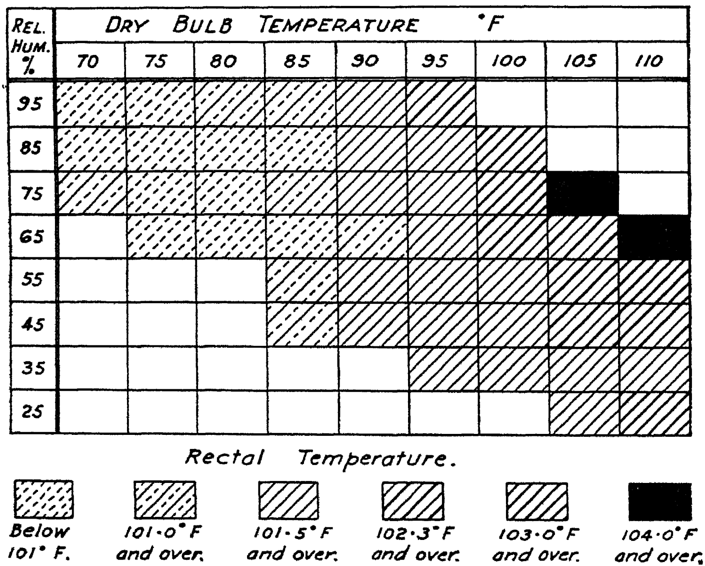
Critical Temperatures.—At room temperatures of 90 degrees-95 degrees F., the sheep begins to show evidence of disturbance in its equilibrium.

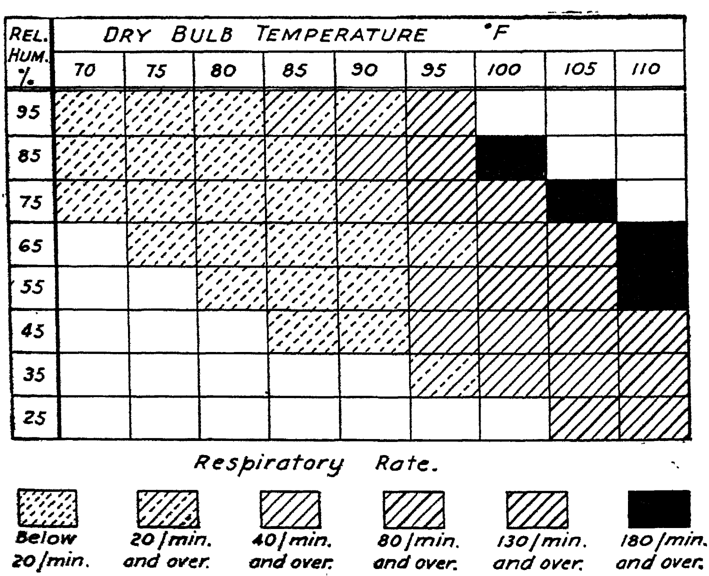
Open-mouthed panting replaces closed-mouthed breathing when the rectal temperature reaches 106 degrees F. A rectal temperature of 107 degrees F. is near the limit of continued existence as an integrated organism. Only when the relative humidity is above 65 per cent. is the sheep unable to tolerate atmospheres of 105 degrees and 110 degrees F. for seven hours.

Methods of Heat Regulation.—The sheep appears to be outstanding amongst domestic animals in tolerating hot atmospheres, indicating a high development of its heat-regulatory mechanism.

The thick fleece of the sheep would tend to reduce the amount of heat dispersed through the channels of radiation and conduction when the atmospheric temperature is below body temperature. On the other hand, the fleece may be of advantage to the sheep in a hot dry atmosphere, forming a protective layer.

The sheep uses evaporation of water from the respiratory passages to some extent in increasing heat loss, but does not possess the wide open mouth and drooling tongue of the dog. It, however, keeps its lips moist by licking and dipping in water, and there is some movement of the tongue at high temperatures.





TEXT FIGURE 5.

Diagrammatic Representation of the Comparative Effects of Temperature and Humidity upon the Reactions of the Sheep.

Increased respiratory ventilation can account for only part of the increased evaporation. Sweat glands have been found over the body of the sheep [Dukes, 1937], so that increased insensible cutaneous evaporation and sweating could probably account for the difference. It remains to be seen whether this can account for the marked superiority of the sheep.

Acclimatisation.—No evidence of an acclimatisation to repeated exposure was obtained with the sheep.

Heat Effects.—The only visible effect of heat on the sheep is shown in its respirations, which increase with rise of rectal temperature above 103 degrees F. At a body temperature of 106 degrees, the rapid respirations of about 240/min. change to panting with mouth slightly open and tip of tongue protruding. It keeps its lips moist by licking and dipping in water, and exercises its tongue, causing a movement of air over the moist surface.

In these experiments we did not take the animal beyond 107 degrees F.

SUMMARY.

Experiments are described in which three merino wethers were subjected to hot atmospheres of different temperatures and humidity for seven hours. The following observations were made and conclusions reached:—

(1) Rectal temperature rises above normal at a room temperature of 90 degrees F. A reduction of humidity has a sparing action at room temperatures above 95 degrees F.

(2) The pulse-rate tends to rise with high room temperatures.

(3) The respiratory rate rises above normal at a room temperature, which varies from 85 degrees F. with 95 per cent. humidity to 95 degrees F. with 35 per cent. humidity. It may reach 240 per minute at high temperatures (110 degrees F.).

(4) As the respiratory rate rises with exposure to heat, the respiratory volume also rises, but not always to the same extent, as the tidal volume is sometimes decreased to a certain extent.

(5) Oral replacement of water lost by evaporation is accompanied by some reduction in the average body temperature, but not by any other definite differences in the sheep's reactions.

(6) No definite acclimatisation effects were seen when the sheep were repeatedly exposed to either hot wet or hot dry atmospheres.

(7) In neither the hot dry room nor the hot wet room could respiratory evaporation account for more than one-third of the observed weight loss. Skin sweating may help to account for the difference.

(8) The sheep shows by far the greatest tolerance to hot atmospheres of all the animals so far studied by us. It just failed to withstand an atmosphere of 105 degrees F. and 75 per cent. humidity for seven hours, but did withstand one of 110 degrees F. and 65 per cent. humidity.

(9) Open-mouthed panting did not occur until a rectal temperature of 106 degrees F. was reached, and even then, panting was not a marked feature.

(10) The range of variation in one individual of the various reactions investigated is moderately large.

ACKNOWLEDGMENTS.

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CONTRIBUTIONS TO THE QUEENSLAND FLORA, No. 7.

By C. T. WHITE, Government Botanist.

(*Read before the Royal Society of Queensland, 29th September,* 1941.)

The present paper contains additions to the flora of Queensland since the publication of the previous contribution (these Proceedings, Vol. 50, pp. 66-87).

My thanks are due to members of my staff and other botanists, both in Australia and abroad, for much help received. Due acknowledgment has been made under the different plants concerned. One family (Dichapetalaceae or Chailletiaceae) and a genus (Gaertnera-Loganiaceae) are added to the Australian flora. Some of the present paper is based on notes made while I was working at the Royal Botanic Gardens, Kew (Eng.), in 1939.

Family DILLENIACEAE.

Hibbertia hexandra sp. nov.

Frutex magnus vel arbor parva, ramulis foliis subtus pedunculis calycibusque dense stellato-tomentosis. Folia manifeste discoloria elongato-obovata, apice obtusa, subobtusa vel emarginata, basin versus in petiolum gradatim attenuata, supra subscabra, subtus dense et submolliter stellato-tomentosa, costa media supra impressa subtus elevata, nervis secundariis supra obscuris subtus visibilibus sed vix prominulis, lamina 2·5–6 cm. longa, 0·6–1·5 cm. lata, petiolo 0·5–2 mm. longo. Flores axillares, solitarii, pedunculis robustis unifloris 0·7–1 cm. longis, apice bracteam hypocalycinam gerentibus. Bractea linearis, 4 mm. longa, dense stellato-tomentosa. Sepala libera, 3 exteriora oblongo-lanceolata, 7–8 mm. longa, extus dense stellato-tomentosa, intus in parte inferiori glabra, 2 interiora extus dense stellato-pubescentes, intus prope apicem pilis paucis stellatis vestita. Petala 7 mm. longa. Stamina 6, glabra, filamentis leviter applanatis, 1·5 mm. longis, antheris 2 mm. longis. Stamininodia O. Carpella 2, 2–ovulata, pilis longis albis dense vestita, stylis glabris.

Moreton District.—Lamington National Park, Macpherson Range, alt. 1,000 m., growing in great profusion on edge of swamps in rather shallow soil overlying trachyte. C. T. White, 11187 (type: flowers), 22nd Oct., 1934 (large shrub or small tree, leaves rather dull green above, markedly paler beneath, flowers yellow). Same locality, scrubby forest country. C. T. White, 11384 (flowers), Dec., 1937 (small tree or large shrub). Mt. Greville Gorge, E. J. Smith, No. 9 (flowers), 20th April, 1938.

In systematic position, the present species belongs to Bentham's section Euhibbertia, and comes between *H. hermanniaefolia* DC. and *H. velutina* R.Br. In general appearance, it very closely resembles *H. melhanoides* F. Muell. (which is doubtfully distinct from *H. velutina* R.Br.), but these species all differ in possessing indefinite stamens. In geographical range, it comes between *H. hermanniaefolia* DC. and the other two species mentioned.

Family CRUCIFERAE.

Cardamine circaeoides Hook. f. & Thompson, Jour. Linn. Soc. V. 144.

Cook District.—North Toohey Creek (prostrate scrambler), growing in crevices of rocky creek bed, North Queensland. H. Flecker, North Queensland Naturalists' Club, Herb. No. 3366 (pods), 23rd May, 1937.

A native of India not previously recorded for Queensland. The specimen collected by Dr. Flecker is a good match for Indian material.

Lepidium bonariense L. species plant. ed. 1 (1753), p. 645.

Queensland.—Maranoa District, Roma, moderately common weed about the town, particularly in sandy soil, C. T. White, No. 9435 (in full fruit), 29th Oct., 1933. Darling Downs.—Wallangarra, weed in railway station yard, C. T. White, No. 9429 (flowers and young fruit), 14th Oct., 1933. Leichhardt District.—Wandoan, near rail track and water tank. C. E. Hubbard (Flora of Queensland, No. 4931 (flowers and fully developed silicules), 15th Nov., 1930 (erect, green leaves).

New South Wales.—Grafton (naturalised weed about the town), C. T. White, No. 10116 (flowers and fully developed fruits), 11th Nov., 1934 (herb about 18 in. high, very dense growth).

The above specimens are, I think, correctly determined. They differ from the typical form in being slightly more pubescent and in the silicules being more prominently reticulate. A specimen distributed by Herter (Plantae Uruguayensis No. 64/76083) seems an exact match for the Australian specimens.

A native of South America, where it has a wide distribution through Brazil, Uruguay, Argentine, and Chili.

Lepidium perfoliatum L. Sp. Plantarum 643.

Moreton District.—Botanic Gardens, Brisbane, a few odd plants seen growing among street sweepings, E. W. Bick, Nov., 1916.

A native of South-eastern Europe and Western Asia.

Family PITTOSPORACEAE.

Pittosporum melanospermum F. Muell. Fragm. Phtyogr. Austr. 1, 70 (1859).

P. setigerum F. M. Bailey. Queens. Fl. 1, 69, 1899.

Cook District.—Cape York Penins., W. Hann (Queensl. Govt. Exped.), No. 98 (shrub with corrugated bark). Walsh River, T. Barclay Millar.

The species, as I understand it, has a wide range through North Queensland and the Northern Territory.

Bentham (Fl. Austral. 1, III.) quoted specimens from Keppel Bay (R. Brown). These were made the type of a new species by K. Domin (*P. queenslandicum*), but on the type sheet at Kew, Spencer Moore has written "*P. melanospermum* Benth. pro parte non F. Muell. This has been described by Domin as *P. queenslandicum*, it is conspecific with *P. ferrugineum* Ait.," and I fully agree with his determination. Bentham l.c. made a variety *lateralis* based on two collections, the one from York Sound, N.W. Australia (A. Cunningham); the other from Whitsunday Island (Henne). The former, Domin has made a distinct species—*P. resinosum* Domin—the other, Domin has written on the Kew sheet "This plant is Celastrus dispermus F. Muell."—a determination which is obviously correct.

Family FLACOURTIACEAE.

Flacourtia Cataphracta Roxb. in Willd. Sp. Pl. IV. 830.

Cook District.—Daintree River, Dr. H. Flecker, N.Q. Nat. Club. No. 7067 (male flowers), 13th Dec., 1940 (tree, 30 ft. high).

A native of India, widely cultivated in Queensland, and here and there subspontaneous, especially along creeks. The Daintree River specimen is probably an escape from cultivation.

Family HYPERICACEAE.

Harungana madagascariensis Poir. in Dict. Sc. Nat. XX. 307.

Cook District:—Frenchman's Creek, Babinda, L. J. Brass and C. T. White, No. 331 (type: flowers and fruits), 25th Sept., 1937. Small tree 8–10 m. high, in rain-forest regrowth. Palma, Dr. H. Flecker (flowers) on 29th Oct., 1939, N.Q. Nat. Club. No. 6403—tree near watercourse, main highway.

I had at first thought this might be a new species allied to the African and Madagascar plant. I sent specimens to the Royal Botanic Gardens, Kew, where they were compared for me by Messrs. Summerhayes and Burtt of the Herbarium staff. They have reported that—

"The Queensland material agrees very closely with this species in nearly all respects, but has the leaves strictly oblong-elliptical, whereas in *H. madagascariensis* the leaves are usually rather wider at the base. In some specimens, however, the leaves are practically identical with those of the Australian material. The fruits in the latter seem to be slightly smaller and more brightly coloured than in *H. madagascariensis*, but it does not seem advisable to emphasise this difference, as we have only one gathering from Queensland. Summing up, such differences as do exist between the African and Australian specimens seem insufficient to justify the creation of a new species."

There is a possibility that the plant may be a naturalised one.

Family MALVACEAE.

Abutilon Andrewsianum W. F. Fitzgerald in Jour. & Proc. Roy. Soc. West Aus. Vol. 3, p. 172 (1918).

A. propinquum W. V. Fitzg. l.c.

A. flavum Ostenfeld. Dansk. Bot. Arkiv. 2 (8) 21. 1918 non *A. flavum* Ulbrich (1913).

Western Australia.—Lennard, Barker, Fitzroy, Adcock, Hann and Isdell Rivers (W. V. Fitzgerald l.c.). Derby, C. H. Ostenfeld No. 1171. 7th Nov., 1914.

Northern Territory.—Settlement Creek, L. J. Brass, No. 321, April, 1923.

Queensland.—Cook District: Cape York Peninsula, W. Hann, No. 76 (Cape York Penins. Exped.). Gilbert River (on river bank), L. J. Brass, No. 425, March, 1925. Burke District: Julia Creek, C. T. White, August, 1916.

Hann's and Brass's specimens from North Queensland are more tomentose than those from Western Australia, but otherwise agree fairly well with co-type material of Fitzgerald's species at Kew. C. T. White's specimens from Julia Creek are much more robust and more densely tomentose, but I do not think can be separated specifically. Brass's from the Northern Territory are an exact match for Ostenfeld's plant except that the leaves are larger approaching indica. The leaves on the twig measure up to 9 by 5·5 cm., a detached leaf which I have little doubt, however, is correctly matched measures 18 by 15 cm. On the lower surface is a very close white tomentum like that of *A. indicum* Sweet; this change in pubescence with age is a fairly common feature in Malvaceae and Sterculiaceae. In his original description Fitzgerald described the petals at the base and staminal column as glabrous. In Ostenfeld's plant and in the Queensland specimens the petals are pubescent at the base and the staminal column glabrous or nearly so. In Brass's specimens from the Northern Territory the staminal column is hairy as in Fitzgerald's *A. propinquum*. I think, therefore, it is best to regard all three species as the same and to allow the plant a wide distribution through North Australia.

Abutilon arenarium n. sp.

Suffrutex erectus ramosus dense stellato-tomentosus et caulibus pilis longis simplicibus vestitis, distantim foliatis. Folia petiolata; petioli 0·3-1·5 cm. longi, laminis multo breviores; laminae oblongae 2-6 cm. longae, 0·5-2 cm. latae, crenulato-serratae ad basi plerumque 7-nerviae, leviter cordatae, apice obtusae minute mucronulatae vel apiculatae sed apiculo ipso deciduo, nervis et venulis supra obsoletis leviter impressis subtus elevatis; stipulae subulatae. Flores parvi flavi, longe pedicellati; pedicelli gracili 1-2·5 cm. longi, ca. 2 mm. infra apicem valde articulati; calyx late campanulatus profunde 5-fidus, 4 mm. longus; corolla calycem subduplo superans, ad 1 mm. longitudinis columnae staminali adnata; columnae pars libera brevis ad basin 2 mm. lata. Calyx fructifer 5 mm. longus 8 mm. latus aliquantum accrescens. Capsula 7 mm. alta 6 mm. diam. truncata. Capsella 7-9 dorso stellato-tomentosa, pilorum fasciculis densis vel distinctis, rotundata sed ad apicem minute apiculata; semina reniformia subangularia ad angulos tenuiter puberula.

Mitchell District.—Torrens Creek, C. T. White, No. 8663 (type: flowers and fruits), 19th March, 1937 (undershrub flowers yellow); 10 miles N.W. of Longreach (on sandy ridges), S. L. Everist and C. T. White, No. 110 (fruits), 28th May, 1936 (openly branched subshrub).

Among previously described Australian species the closest affinities are with *A. indicum* Sweet and *A. Andrewsianum* W. V. Fitzg. (sens lat). The three species can be distinguished as follows:—

Plant with a close grey tomentum not markedly stellate under a lens (X 10). Leaves cordate ovate to cordate-orbicular. Capsules 3 cm. or more in diameter. Carpels readily seceding at maturity and clothed in the bud with long spreading hairs. .. *A. indicum.*

Tomentum not tight and close and usually with long simple hairs intermixed. Leaves cordate ovate. Capsule 1.8 c.m. diameter, carpels persistent and clothed on the back with stellate hairs .. .. *A. Andrewsianum.*

Leaves oblong, slightly cordate at the base. Tomentum markedly stellate under a lens (X 10) and mixed with long simple hairs. Capsule 6 mm. diameter, carpels persistent .. .. *A. arenarium.*

A. oxycarpum F. Muell. and its related species *A. malvifolia* J. M. Black and *A. lobulatum* Domin are allied but distinguished by their carpels possessing long spreading pungent points.

Hibiscus Krichauffianus F. Muell. Report Babbage's Exped. 7, 1858.

Gregory North District.—Glengyle Station, about 80 miles north of Birdsville. Growing on edge of sandhill. S. L. Everist and L. S. Smith, No. 103, 20th Jan., 1937. (Recorded from Cooper's Creek in Bailey's "Queensland Flora," but so far as we know, the above is the first authentic specimen from Queensland territory). Determination by L. S. Smith.

Family STERCULIACEAE.

Keraudrenia corollata (Steetz) Domin in Bibl. Bot. 89 (v.) 975, 1928, var. *denticulata* n. var.

Folia grosse et irregulariter dentata vel serrato-denticulata, ad 12 cm. longa et 4 cm. lata. Pedunculi 1-2·5 cm. longi; bracteae ovatae, 4-5 mm. longae, 2 mm. latae peracutae. Calyx albus vel demum carneus. Petala minuta, filamentis similia.

Moreton District.—Ithaca Creek, near Brisbane, F. M. Bailey (flowers and old capsules), Sept. Aspley, near Brisbane, H. Tryon and C. T. White (type of the variety—flowers and old capsules), 19th Dec., 1928.

Differs from the type in having larger, broader, toothed leaves, broader bracts, and white, not coloured, calyx.

Keraudrenia Hillii F. Muell. ex. Benth. Fl. Austr. 1, 246, 1863, var. *velutina* n. var.

Folia serrulato-denticulata, ad 12 cm. longa et 3·5 cm. lata, supra velutina, pilis stellatis numerosis sed distinctis vestita.

Moreton District.—Glass House Mts., C. T. White, Sept., 1909. Saddle Back Mountain, Elimbah, C. T. White, No. 3229 (type of the variety—flowers and capsules), 12th Sept., 1926.

Family TILIACEAE.

Corchorus sidoides F. Muell. Fragm. Phytogr. Austr. III., 9, 1862.

Burke District.—Woolgar, E. W. Bick, Aug., 1915. These specimens are a good match for R. Brown's Carpentaria ones. So far as I know, they are the first authentic specimens from Queensland territory.

Triumfetta plumigera F. Muell. Fragm. Phytogr. Austr. I., 69, 1859.

Burke District.—Lawn Hill, H. I. Jensen, No. 88, May, 1940. Determination by L. S. Smith.

Family RUTACEAE.

Boronia artemesiaefolia F. Muell. Fragm. Phytogr. Austr. I., 66, 1859.

Cook District.—The Gorge, Mt. Mulligan, Dr. H. Flecker (flowers), 2nd April, 1934. New for Queensland.

These specimens approach some from Vanstittart Bay, collected by A. Cunningham, and which he labelled *B. candicans*. Bentham in the Flora Australiensis referred them to *B. artemisaefolia* F. Muell. var. *Wilsoni* F. Muell., a determination, however, in which I cannot agree.

Boronia obovata sp. nov.

Frutex ramulis pilis stellatis ferrugineis dense obsitis. Folia trifoliolata; petiolus communis dense ferrugineo-tomentosus, 1–2 mm. longus; foliola anguste obovata 1–2 cm. longa, 4–7 mm. lata, discoloria, supra pilis stellatis paucis vestita, subtus dense stellato-tomentosa, costa media supra sulcata, subtus elevata, nervis lateralibus obscuris. Flores axillares, solitarii, pedunculis 2–3 mm. longis. Sepala linearia extus pilis stellatis paucis obsita, apice acuta, 4 mm. longa, 1 mm. lata. Petala tomentosa, anguste ovata, 8 mm. longa, 3 mm. lata. Stamina 3 mm. longa, filamentis applanatis 2 mm. longis in parte inferiori pilis longis paucis vestitis, apicem versus incrassatis verruculosis, antheris cordatis 1 mm. longis, minute sed prominenter apiculatis. Cocci crustacei, minute verruculosi, transverse venosi, 6 mm. longi; semen nigrum.

Leichhardt District.—Blackdown Tableland, H. G. Simmons, No. 3 (flowers and fruits), Sept., 1937.

The affinities of the present species are with *B. triphylla* Sieb., which differs in having narrower acute leaves.

Boronia repanda Maid. & Betche, Proc. Linn. Soc. N.S.W., XXXI., 732 (1906), var. *alba* var. nov. Flores albi.

Darling Downs.—Thulimbah (obtained at Wild Flower Show, Queensland Naturalists' Club, 9th Sept., 1933). C. T. White, No. 9234. The colour of the flowers of normal *B. repanda* ranges from pale to very dark pink.

Boronia rivularis sp. nov.

Frutex gracilis, glaber. Folia imparipinnata, 3–6 juga; rhachis leviter alata, 2·5–4·5 cm. longa; foliola lanceolata, submembranacea, margine integra, vel leviter crenulato-dentata, 1·7–3 cm. longa, 3–8 mm. lata, apice acuta, basi angustata. Cymae 5–9 florae, ad apices ramulorum brevium lateralium dispositae, ramis subangularibus. Flores rosei, calycis lobi ovati, 1 mm. longi, petala ovata 6 mm. longa. Stamina biserialia, filamentis applanatis pilis longis albis vestitis, antheris glabris. Ovarium glabrum, stylus pilis paucis vestitus, stigmate parvo capitato. Cocci 1-spermi, 4 mm. longi; semen nigrum.

Queensland.—Wide Bay District, Fraser Island, in damp gullies, C. T. White, No. 2505 (type: flowers), May, 1925 (apparently similar to *B. thujona* Penfold & Welch, but leaves lacking characteristic "black currant" odour recorded as a characteristic feature of that species) (flowers and fruits), Oct., 1921 (sine no.). W. R. Petrie (shrub 2–3 feet high, rose flowers); these specimens distributed from Herb. Kew. Flora of Queensland comm. C. E. Hubbard under No. 5472 as *B. pinnata* Sm. Upper Noosa River, growing on banks of the river, Jas. Keys, No. 61 (slender shrub).

I had previously placed this plant under *B. Muelleri* Cheel and *B. thujona* Penfold & Welch. Mr. E. Cheel, who has done considerable work on *Boronia*, saw these specimens, and considered if *B. thujona* was definitely distinct from *B. Muelleri*, these specimens were intermediate. A portion of the gathering of Keys was evidently seen by Domin, who referred it with some hesitation to *B. pinnata* Sm. var. *Muelleri* Benth. (*B. Muelleri* Cheel.), *see* Bibl. Bot. 89, p. 839. *B. Muelleri* differs in having raised glands on branchlets and leaves, and *B. thujona* in having serrulate leaflets and, when fresh, emitting a "black-currant" odour

when crushed. *B. pinnata* Sm. and its allies is a group in which two courses lie open: either to treat *B. pinnata* Sm. as a polymorphic species with a wide distribution, or to split off a number of individual species, all of which have definite geographical and habitat limits.

Eriostemon queenslandicus sp. nov.

Frutex 30–50 cm. alt., ramis robustis erectis glabris simplicibus vel in parte superiore pauci-ramosis. Folia anguste lanceolata, 1·8–2·5 cm. longa, 1·5–3 mm. lata, crassa, apice acuminata subpungentia, basi sessilia vel in petiolum indistinctum gradatim angustata, enervia, supra concava, vel plana sed margine semper incurva, plerumque subtus plus vel minus verrucosa sed verrucis (glandulis) saepe paucis vel absentibus. Flores axillares; pedunculis unifloris vel rarissime trifloris, 2 mm. longis, ad apicem annulo bractearum parvarum ornatis; pedicellis 4 mm. longis robustis apicem versus incrassatis. Calyx 3 mm. diam., 5–lobatus, lobis late triangularibus subobtusis. Petala oblonga, 6–7 mm. longa, 2·5 mm. lata. Stamina 10, filamentis applanatis, apicem versus gradatim angustatis, basi 0·5 mm. latis, margine pilis longis albis obsitis. Cocci 5, apice oblique truncati, angulo exteriore in acumen producti.

Moreton District.—Moreton Bay (northern end), Miss E. N. Parker (flowers), July, 1918. Coolum, very common in swamps, C. T. White, No. 11416 (flowers), April, 1938 (shrub 1–2 ft. high, usually several stems from a common stock, flowers opening white, turning to pink). Maroochy, F. M. Bailey (flowers), July, 1879. Beerwah, C. T. White, No. 974 (flowers), Sept., 1921 (distributed as *E. scaber* Paxt.). Caloundra, F. H. Kenny (flowers), Aug., 1906. Caloundra, common on high wallum, C. T. White, No. 9654 (flowers and young capsules), Dec., 1933 (undershrub with numerous stems from a common stock, flowers flesh-coloured), distributed as *E. scaber* Paxt. Caloundra, very common on sandy wallum flats, S. L. Everist, No. 454 (type: flowers), August, 1933 (low shrub or subshrub, flowers pink); determined and distributed as E. *scaber* Paxt. Between Beerwah and Landsborough, in open situations amongst masses of dwarf shrubs, grey sandy soil, C. E. Hubbard, No. 3114 (flowers), 22nd June, 1930 (rigid erect solitary stems, dull green fleshy leaves, pale pink or flesh-coloured flowers), determined and distributed from Herb. Kew. as *E. glasshousiensis* Domin. forma.

Wide Bay District.—Near Lake Wybah, Mrs. Estelle Thomson; Lake Cootharaba, Jas. Keys; Coondoo Creek, W. D. Francis; Noosa Heads, H. A. Longman; Wide Bay, H. A. Longman.

The present species is undoubtedly close to *E. scaber* Paxt., and is mainly differentiated on habit. The geographical limits of both species are rather circumscribed, and there is a break of 700 miles between them. The two species can be separated as follows:—

Shrub about 1 m. high, with much branched stems, branches hairy, leaves markedly concave and warty beneath .. *E. scaber.*

Shrub, 30-50 cm. high, stems simple or with a few branches in the upper parts (probably due to injury), branches glabrous, leaves frequently nearly flat and often smooth or with few warts (verrucose) on the lower face .. .. *E. queenslandicus.*

E. scaber Paxt. has been recorded from the Glass House Mts. District by Mueller, Domin, and Bailey, but I have no doubt these represent *E. queenslandicus*, C. T. White, which is very abundant in this district. *E. scaber* Paxt. should thus be excluded from the Queensland Flora until authentic specimens have been collected.

Evodia micrococca F. Muell. var. *pubescens* Fraser & Vickery in Proc. Linn. Soc., N. S. Wales, Vol. LXII., 289, 1937.

Moreton District.—Ferny Grove, nr. Brisbane, C. T. White, Nov., 1924 (sine no.); near Brisbane, H. A. Longman (ex Herb. Kew).

N. S. Wales.—Hastings River, A. Cunningham, No. 6, May, 1819; same locality, C. Moore; E. Australia, R. Brown, both glabrous and pubescent forms under No. 5333 (all ex Herb. Kew).

Evodia vitiflora F. Muell. Fragm. VII., 144 (1871).

E. littoralis F. M. Bailey, Bot. Bull. XIV. (Dept. Agric., Brisbane) 7 (1896), Queensl. Flora 1, 201 (1899) non Endl.

This species has a wide range from Northern New South Wales to North Queensland. Some Queensland specimens collected at Eumundi were referred by Bailey to *E. littoralis* Endl. Specimens collected by Cunningham on Norfolk Island were distributed as from the Brisbane River, but according to notes on the sheets in the Herb. Kew, this was an error. *E. littoralis* should be deleted from the Australian flora.

Phebalium Beckleri (F. Muell.) Engler in Engler and Prantl. Pflanzenf. III. (iv.), 141, 1896.

Moreton District.—Springbrook, Macpherson Range, in open rain forest near edge of cliff, C. E. Hubbard, No. 4225 (advanced flowers), 28th Sept., 1930 (shrub 4–7 ft. high; leaves dark green and glossy; flowers white). Collected by W. Rudder (distributed from Herb. Kew as *P. elatius* Benth. under C. E. Hubbard, No. 4017. C. T. White, No. 6238 (very handsome and floriferous shrub, leaves glossy green above, somewhat paler beneath). C. T. White, No. 7064, common on edge of rain forest (flowers), 10th Aug., 1930 (handsome shrub 4 ft., flowers white). Lamington National Park, common on cliff edges in scrubby forest, C. T. White, No. 11385 (fruits), Dec., 1937 (large shrub).

The above, with the exception of White 11385, were variously distributed from Herb. Kew, Arnold Arboretum, and Herb. Brisbane as *P. elatius* Benth. The true *P. elatius* Benth. has not yet been collected in Queensland.

Zanthoxylum suberosum nom. nov.

Z. inerme White and Francis Bot. Bull. (Dept. Agric. Brisbane) xxii. 6, cum ic. 1920.

Non *Z. inerme* Mocino and Sesse Fl. Mexico. ed. 2, 320, 1894.

Non *Z. inerme* Koidz. Bot. Mag. Tokyo 33, 218, 1919.

Cook District.—Near Atherton, C. T. White (type: fruits), Jan., 1918, near Boar Pocket, Atherton Tableland. J. F. Bailey (fruits), June, 1899 (medium-sized tree, corky bark). Ravenshoe, C. J. Samundseth (fruits), June, 1940. Rooty Creek, near Mona Mona Mission Station, H. Flecker (old fruits), Oct., 1939. Scrubby Creek, Herberton, common in poor rain forest, S. F. Kajewski, No. 1358 (old fruits), Nov., 1929 (small tree about 8 m. high, leaves with a citron scent).

Kajewski's No. 1358 was recorded by White (Contr. Arn. Arb. 4, 48, 1933) and distributed erroneously as *Melicope erythrococca* Benth.

Zieria aspalathoides A. Cun. var. *obovatum* n. var.

Petiolus 0·5–1 mm. longus; foliola obovata, apice rotundata vel subacuta, margine leviter revoluta, discoloria, supra glabra vel pilis longis paucis vestita, subtus pallidiora vel albescentes, hirsuta vel glabrescentes, 0·6–1 cm. longa, 0·2–0·5 cm. lata.

Cook District.—Herberton, Dr. F. Hamilton Kenny (type of the variety: flowering specimens), Jan., 1912. Rev. J. E. Tenison Woods, J. F. Bailey (fruiting specimens), June-July, 1899. Rev. N. Michael (Nos. 363 and 1649) (small shrub 3–4 ft.). R. C. Ringrose No. 4 (including a narrow-leaved form). Stannary Hills, Dr. T. L. Bancroft, No. 287.

At first glance it is hard to reconcile the above specimens specifically with *Z. aspalathoides* A. Cunn., a species with a wide distribution through N. S. Wales and Queensland. I had drawn up a description of them as a new species, but the discovery among the material in the Queensland Herbarium of typical *Z. aspalathoides* from Herberton and further of intermediate ones from the same place induced me to the conclusion here published.

Zieria aspalathoides A. Cunn. var. *intermedia* n. var.

Petiolus ad 1 mm. longus sed saepe brevior et obsoletus foliola 1 cm. longa ad 3 mm. lata sed saepe angustiora, margine valde vel leviter revoluta.

Cook District.—Ravenshoe, E. W. Bick, No. 116 (flowers and fruits), June, 1913.

Zieria compacta C. T. White sp. nov.

Z. Smithii Andr. var. *parvifolia* Benth. pro parte.

Frutex compactus, ramulis robustis dense pubescentibus. Folia trifoliolata; petiolus communis dense et breviter hirsutus, 2–4 mm. longus; foliola lanceolata supra glabra atro-viridia, costa media sulcata, nervis obsoletis, subtus canescentia dense velutino-pubescentia costa media elevata, venis lateralibus subindistinctis, 6–7 in utroque latere, 1–3 cm. longa, 0·5–1 cm. lata. Cymae folia aequantes vel excedentes, 3–9–florae, pedunculo communi dense tomentoso circa 1 cm. longo, bracteis ad 4 mm. longis. Calyx alte 4–fidus, lobis late deltoides 1 mm. longis. Petala extus dense tomentosa lanceolata 4 mm. longa. Stamina glabra, antheris obtusis vix 1 mm. latis. Gynaecium glabrum. Carpella 5 mm. longa, valvis prominule venosis, seminibus atro-castaneis, tenuiter reticulato-striatis.

Queensland.—Darling Downs: Messines, near Stanthorpe, alt. 2,900 ft. Ex Brisbane Wild Flower Show, C. E. Hubbard (type: flowering specimens), 13th Sept., 1930 (leaves dark green above, greyish green below, flowers pale pink). Crow's Nest, Dr. F. H. Kenny (flowers), Sept., 1920. Crow's Nest, C. T. White (old flowers and young fruits), Oct., 1921 (small bush of dense growth, flowers white).

New South Wales.—Near Tenterfield, C. Stuart; Wallangarra, J. L. Boorman (distributed ex Nat. Herb., Sydney, as *Zieria Smithii* Andr. var. Fraseri F. Muell. ined.) (nearly ripe fruits), Oct., 1901; Wallangarra, E. Betche (ripe fruits), Dec., 1891 (distributed ex Nat. Herb. Sydney as *Z. Smithii* Andr. var. *parvifolia*).

Zieria compacta C. T. White var. *glabrata.*

Ramuli glaberrimi; foliola 2–3 cm. longa, ad 6 mm. lata sed saepe angustiora et marginibus valde revoluta.

Leichhardt District.—Blackdown Tableland, H. G. Simmons, No. 57 (flowers), Sept., 1937.

Zieria compacta C. T. White var. *robusta*.

Ramuli petiolisque tenuiter stellato-tomentosi; foliola 3–4 cm. longa, 4–6 mm. lata.

Leichhardt District.—Blackdown Tableland, H. G. Simmons, No. 73 (flowers), Sept., 1937.

Zieria granulata C. Moore ex Benth. var. *adenodonta* F. Muell. ex Maid & Betche, Proc. Linn. Soc., N.S.W., xxvi., 80, 1901.

Moreton District.—Lamington National Park (Yangabla, Nixon's Creek watershed). J. A. Gresty, No. 782 (flowers), Aug., 1941.

Not previously recorded for Queensland. The normal form has not yet been found in Queensland, specimens previously referred to it belong to *Z. furfuracea* R.Br. (determination by W. D. Francis).

Zieria rimulosa n. sp.

Frutex ramulis pubescentibus deinde glabris et valde rimulosis. Folia glabra trifoliolata, petiolus communis ca. 2·5 mm. longus; foliola obovato-lanceolata vel lineari-obovata, 1·2–1·5 cm. longa, ad 5 mm. lata sed saepe angustiora et marginibus valde revoluta, apice obtusa, basin versus gradatim angustata. Cymae 7–florae, pedunculis foliis ca. 1½ plo superantibus, tenuiter tomentosis, 1·7–2 cm. longis. Calyx glaber, leviter verniculosa, alte 4–lobus, lobis ovatis ca. 1 mm. longis. Petala ovata villosa, 4 mm. longa. Antherae obtusae. Carpella (vix matura) glabra, 4 mm. longa.

Cook District.—Mt. Mulligan, Miss McDonald (flowers and young fruits), 21st April, 1931 (ex Herb. North Queensland Nat. Club No. 450), type Herb. Brisbane. Co-type Herb. North Queensland Nat. Club, Cairns.

This plant had previously been referred with doubt to *Z. pilosa* Rudge. At first sight its affinities seem to lie with that species and its allies, but the absence of any apiculate point to the anthers place it next to *Z. Smithii* Andr. and cognate species.

From *Z. Smithii* it differs in its very much smaller leaves and infloresceuse 1½ times or more longer than them.

Family MELIACEAE.

Amoora ferruginea sp. nov.

Arbor 10 m. alta, ramulis robustis, lenticellatis, partibus junioribus pilis stellatis atro-ferrugineis densissime obsitis. Folia imparipinnata, 6–7–juga; petiolus cum rhachi ferrugineo-pubescens, deinde glaber, 22–45 cm. longus; foliola elliptica, apice obtusa vel subobtusa, basi obtusa vel cuneata, costa media excepta glabra, utrinque opaca, subtus prominenter pallidiora, nervis lateralibus ca. 16 tenuibus supra subobscuris subtus visibilibus sed vix prominulis, petiolo valido 5 mm. longo, lamina 15–24 cm. longa. Paniculae axillares foliis multo breviores patentes et multiflorae, dense ramulosae ad 30 cm. diam. (Brass & White 262) vel angustae et pauci-ramosae (Herb. N.Q. Nat. Club, Nos. 2141 and 7272), ramulis pedicellis calycibusque pilis stellatis rufo-ferrugineis densissime obsitis. Calyx late cupulatus, trilobus, 3 mm. diam. (Brass & White 262) 1–5 mm. diam. (Herb. N.Q. Nat. Club, Nos. 2141 and 7272). Petala 3, rotunda, concava, subcoriacea, extus dense ferrugineo-pubescentes, margine glabra, intus glabra, nitida, 3 mm.

diam. (Brass & White 262) 5 mm. diam. (Herb. N.Q. Nat. Club, Nos. 2141 and 7272). Tubus stamineus glaber, antheris 6; Pistillum triloculare, pilis floccosis rufis dense vestitum, Fructus globosus 2·5 cm. diam., pilis asperis stellatis ferrugineis dense vestitus.

Cook District.—Foothills of Thornton Peak (Mt. Alexander), alt. 250 m., in rain forest, L. J. Brass and C. T. White, No. 262 (type: flowers), 20th Sept., 1937 (tree 10 m. high). Fishery Falls, H. Flecker (flowers), 16th Aug., 1936 (Herb. North Queensland Naturalists' Club, No. 2141). Mt. Lewis, T. Carr (fruits), 1st Feb., 1941 (Herb. N.Q. Nat. Club, No. 7272).

Very distinct from the only other known Australian member of the genus *A. nitidula* Benth. which is glabrous in all its parts.

I was undecided whether to regard Brass & White 262 and the specimens received from the North Queensland Naturalists' Club as the same or distinct species. Apart from the character of the inflorescence, their appearance is similar, and though the flowers of the latter are larger, they have exactly the same floral structure.

Dysoxylum arborescens Miq. Ann. Mus. Bot. Lugd-Bat. IV., 25, 1848.

D. Nernstii F. Muell. Fragm. V., 176, 1866.

Miquel l.c. refers to having received specimens of *D. arborescens* from North Australia from Ferd. Mueller. I have seen the type of *D. Nernstii*, and cannot separate it from extra-Australian specimens of *D. arborescens* Miq. Merrill and Perry (Journ. Arn. Arb. xxi., 303, 1940) have already remarked on the similarity of *D. Nernstii* F. Muell. with *D. arborescens* Miq.

Dysoxylum decandrum (Blanco) Merr. in Govt. Lab. Publ. (Philip.), 27, 30, 1905.

D. rufum Benth. var. *glabrescens* Benth. Fl. Austr. 1, 382, 1863.

D. amooroides Miq. Ann. Mus. Bot. Lugd-Bat., 4, 16, 1868.

D. cerebriforme F. M. Bailey, Bot. Bull. xiv. (Brisb.), 7 Pl. I. and II., 1896.

This tree is very common along the Queensland coast from Bundaberg (Burnett District) to Mowbray River (Cook District). I had already stated (N.Q. Nat. vol. 3, p. 34) that Bailey's *D. cerebriforme* was identical with *D. amooroides* Miq. When examining the material of *Dysoxylum* at Herb., Kew, recently, I saw the type specimen of *D. rufum* var. *glabrescens* and should say there is no doubt at all it is the same.

Family CHAILLETIACEAE (DICHAPETALACEAE).

Dichapetalum australianum sp. nov.

Frutex 1·25 m. altus, partibus novellis pubescentibus, mox glabris, ramulis junioribus subangularibus mox teretibus, lenticellatis. Folia lanceolata, breviter petiolata, apice acuminata, in sicco utrinque reticulata, margine undulata, nervis lateralibus in utroque latere ca. 7; lamina 10–13 cm. longa, 3–4 cm. lata; petiolus 2–3 cm. longus. Inflorescentiae laterales, rhachi pilis strigosis sparse obsita; calyx (sub fructu) 5–lobatus, 4 mm. diam., extus sparse pubescens, lobis ovatis 1 mm. longis. Fructus carnosus, 3–lobatus, auriantiacus (fide Brass), in sicco 1·25 cm. longus, 8 mm.–1 cm. latus, trilocularis, loculis 1–2 saepe abortivis.

Cook District.—Slopes of Mt. Fraser, alt. 2,000 ft., in rain-forest gully, L. J. Brass, No. 2510 (fruits), 16th April, 1932 (spreading shrub, 4 ft. high, leaves glabrous and shining, the small veins conspicuous below; fruit fleshy, 3-lobed, orange-yellow).

These specimens were among a collection made by Mr. L. J. Brass in North Queensland on behalf of the Arnold Arboretum. I was not able to place the specimens satisfactorily, and referred them to Dr. E. D. Merrill, who replied: "Brass 2510 . . . . certainly represents *Dichapetalum*, the fruits of which are 1–, 2–, and 3–celled (cf. *D. tricapsulare* (Blanco) Merr."

The family is new to Australia.

Family ICACINACEAE.

Gomphandra australiana F. Muell. Fragm. Phytogr. Austr. vi., 3, 1867.

G. polymorpha F. M. Bail. Queensl. Bot. Bull. viii. (Dept. Agric. Brisbane), p. 71, 1893, non Wight.

North Kennedy District.—Rockingham Bay, J. Dallachy. Herbert River, H. G. Eaton. Cook District.—Barron River, E. Cowley (handsome tree to 60 ft.). Johnstone River, H. G. Ladbrook (small tree). Cairns, L. J. Nugent.

Some of the above were previously referred by F. M. Bailey to *G. polymorpha* Wight, but all agree with Mueller's *G. australiana*, and until authentic material has been gathered, *G. polymorpha* Wight should be deleted from the Queensland flora.

Family RHAMNACEAE.

Cryptandra spinescens Sieb. ex DC. in DC. Prodr. II., 38, 1825.

Darling Downs District.—Glenoie, near Hannaford, growing in red sandy loam. S. L. Everist, No. 1743 (flowers), 7th April, 1939 (densely branched shrub about 3 ft., flowers white).

Determination by S. L. Everist.

This plant is included in the Queensland Flora (p. 275) with the locality as "southern parts of the colony." Previously, however, there were no Queensland specimens in the Queensland Herbarium, hence the above record is interesting as giving a definite locality for the species.

Family SAPINDACEAE.

Toechima dasyrhache Radlk. Proc. Linn. Soc. N.S.W., xxxi., 733, 1906.

Moreton District.—Upper Tallebudgera Creek, C. T. White, No. 6595 (fruits), 20th Nov., 1929 (small tree 5 m., growing along creek bank, only the one specimen seen, capsules red, seed with a shining black testa and small, yellow fleshy aril at the base—very handsome).

These specimens were distributed as *Sarcopteryx stipitata* Radlk. In working through some Papuan and Australian Sapindaceae recently, Dr. Lilian M. Perry noticed the specimens and wrote me as follows:—"Would you check your No. 6595 and see if it belongs to *Toechima*?" There is no doubt this is where it belongs. The Tallebudgera specimens are a good match for White 10464 from Cooper's Creek, Mullumbimby, N.S.W. (in flower), and also distributed as *Sarcopteryx stipitata* Radlk. Both differ from the type in possessing more numerous and smaller leaflets, but are scarcely distinguishable specifically. Apart from these, the species is only known from the type gathering.

Family LEGUMINOSAE.

Acacia Crombiei sp. nov. (Series Uninerves-Angustifoliae).

Arbor glabra ad 10 m. alta, ramulis junioribus triangularibus leviter tortuosis, vetustioribus teretibus costis 3–5 notatis. Phyllodia lineari-lanceolata, recta vel leviter falcata, in sicco pallido-viridia vel glaucescentia, 11–14 cm. longa, 4–6 mm. lata, basi valde angustata, margine valde incrassata, glandula marginali absenti, costa media prominenti, venis lateralibus utrinque prominulis et obscure reticulatis. Pedunculi solitarii, graciles, 1·5–1·8 cm. longi. Flores in capitulum densum dispositi. Sepala 5, libera, lineari-spathulata, ciliolata, 0·5 cm. longa. Petala 5, ovato-lanceolata, 2 mm. longa, margine minute denticulato-ciliolata. Stamina numerosa, 3 mm. longa. Legumen (in specimine meo non maturum) stipitatum, 5–10 cm. longum, 2 cm. latum, inter semina nunc valde nunc haud angustata, margine undulata incrassata, valvis tenuis et valde reticulatis.

Mitchell District.—Near Longreach, J. Crombie, immature pods, May, 1940 (type: flowers), June, 1940.

Mr. Crombie wrote: "In appearance the tree is somewhat like Gidyea or Boree, but is straighter, bushier, and more symmetrical. I know of only one clump of a hundred odd trees of all sizes up to about 30 feet high and 10 inches in diameter. It is on a dry ridge isolated in downs country, and there are no similar trees within at least 40 miles. I have known it for thirty years, and have not recognised it elsewhere or found anybody who knew it."

In botanical sequence it comes into Bentham's Series Uninerves, Section Angustifoliae (Fl. Austr. II., 309), and should be placed between *Acacia Gnidium* Benth. and *A. ramosissima* Benth. It differs from the former in not being resinous, and from the latter in possessing rather prominent anastomosing lateral veins.

Indigofera suffruticosa Miller. Gard. Dict. ed. 8 (1768), No. 2. *I. anil* Linn. Mant. 2, 272, 1771.

This is a very common weed along the Queensland coast from Brisbane to Cairns. It was originally recorded from Bundaberg by F. M. Bailey as *I. argentea* Linn. I have seen these specimens and have no hesitation in placing them under *I. suffruticosa* Miller.

Jacksonia thesioides A. Cunn. ex Benth. Fl. Austr. II., 59 (1864). Banks and Solander, Bot. Cook's Voyage, ed. J. Britten, I., 18, pl. 49.

J. purpurascens F. Muell. IV., 161, 1864.

North Kennedy District.—Rockingham Bay, J. Dallachy (type of *J. purpurascens* F. Muell.). Cook District.—Endeavour River, A. Cunningham (type of *J. thesioides*, A. Cunn.), Banks, and Solander. Watsonville, L. C. Ball. Dimbulah, J. H. Smith. Mt. Fraser, alt. 1,500 ft., gregarious on crest of a granite ridge, L. J. Brass, No. 2424 (immature pods), 9th April, 1932 (much branched shrub 4 ft. high). Thornton Peak, alt. 700 ft., common on quartz ridges, L. J. Brass and C. T. White, No. 272 (flowers), 22nd Sept., 1937 (small shrub, flowers purple). Herberton, Dr. F. H. Kenny, Rev. N. Michael. Stannary Hills, Dr. T. L. Bancroft. Thursday Island, F. M. Bailey. Temple Bay, sandy country, J. E. Young (Wilkins Exped. No. 17), July, 1923. A type piece of *J. purpurascens* F. Muell. has been labelled in pencil in

Hb., Kew, as "*J. thesioides* var." It is the common type in North Queensland. It has more slender branchlets and smaller flowers than typical *J. thesioides*. Both forms are represented in Young's specimens from Temple Bay, they probably run into one another, and I consider it doubtful if they are really even varietally distinct.

Jacksonia vernicosa F. Muell. ex Benth. Fl. Austr. II., 58, 1864.

Cook District.—Newcastle Range, between Forsayth and Einasleigh, on sandstone. L. J. Brass, No. 1760 (flowers), Feb., 1928 (low, much branched shrub).

A definite Queensland locality for the species. These specimens are less vernicose than the type and the flowers are smaller but otherwise they are inseparable.

Psoralea balsamica F. Muell. in Trans. Vic. Instit. III., 55.

Burke District.—Mt. Isa, alt. 1,300 ft., on gully on rocky hill-slopes in reddish-brown soil, C. E. Hubbard and C. W. Winders, No. 7403 (flowers), 9th Feb., 1931 (ex. Herb. Roy. Bot. Gard., Kew). Twelve miles S.W. of Cloncurry, favouring northern slopes of stony hillsides, and inviting strong sunlight in exposed and arid localities, associated with Spinifex (*Triodia*) and Ridge Grass (*Eriachne*), not plentiful, appearing in scattered units, S. E. Pearson, No. 110 (flowers), July, 1941 (plant with single stems, 2–3 ft. high, exuding a sticky substance and possessing a decided odour of mint).

Not previously recorded for Queensland.

Tephrosia varians n. comb.

Galactia varians F. M. Bail., Bot. Bull. x. (Dept. Agric., Brisbane), 22, 1895.

Cook District.—Coolgarra, M. Butler (type), Herberton. Dr. F. H. Kenny. Tate River, A. Straughan (flowers), Feb., 1938 (herb with a carrot-like root, eaten by the natives). Chillagoe, alt. 1,160 ft., in open Eucalyptus forest, in reddish-brown soil amongst grasses. C. E. Hubbard and C. Winders, No. 6759 (flowers), Jan., 1931. North Kennedy District.—Stuart, near Townsville, R. C. Watts (flowers and pods), Nov., 1940.

When recently going through a collection of Australian plants made by Mr. C. E. Hubbard, I recognised his No. 6759, distributed as *Tephrosia* sp. as *Galactia varians* F. M. Bailey. Bailey's plant was obviously placed in the wrong genus, and I thought it might be identical with *T. reticulata* R. Br., but did not feel satisfied. At my request, a comparison of Hubbard's 6759 was made with R. Brown's *T. reticulata* at the Royal Botanic Gardens, Kew. The comparison was made by Messrs. Summerhayes and Burtt, who reported:

"We have only R. Brown's original gathering of *T. reticulata*. This has three or four pairs of leaflets which are sub-densely hairy beneath, and thicker in texture than in *T. varians*; there are no good flowers. Of the two remaining collections cited in Flora Australiensis, A. Cunningham from Sim's Island is quite a distinct species, but we have not seen the Banks and Solander plant. There are two other specimens at Kew named by Bentham (Hann, Cape York, and Cunningham, Endeavour R.), but both these agree more closely with *T. varians*, though they seem to have smaller flowers than in Hubbard 6759. At present the reduction of *T. varians* to *T. reticulata* is not justified, but it will be seen that the material available is not sufficient to say finally that they are distinct."

Family ROSACEAE.

Rubus Moorei F. Muell. in Trans. Philosoph. Instit. Vic. 2, 67, 1858.

This scrambling shrub or vigorous climber is very common in mountainous areas in South-eastern Queensland at altitudes of 2,000–3,000 feet. It is abundant on the Macpherson Range and is found on the Blackall Range at comparatively low altitudes (about 1,500 ft.), but strange to say, I have never seen it on Tamborine Mountain, though I know that locality well.

It occurs both here and in New South Wales in two distinct forms, the one (the type) with the branchlets, under-surface of the leaves and calyces densely clothed with silky hairs; the other with the branchlets, and under-surfaces of the leaves quite glabrous, or with a few hairs on the midrib and tufts in the axils of the primary nerves. The leaves and flowers are also larger than in the type, and the calyces much less sericeous. The inflorescence is larger and looser and the branches less sericeous. At first sight, the two forms seem so distinct as to be worthy of distinctive specific rank, but I have found what I take to be intermediate forms (unfortunately not in flower or fruit) and think it better for the time being to regard them as races or forms of the one species.

They may be distinguished as follows:—

f. sericea. Rami dense sericeo-tomentosi. Foliola 4–6 cm. longa, 2–3 cm. lata, subtus pilis sericeis longis dense obsita. Inflorescentia 2–4 cm. longa, conferta. Calyx extus densissime sericeus.

f. glabra. Rami glabri. Foliola 6–12 cm. longa, 3–6 cm. lata, utrinque glabra vel costa media pilis paucis obsita et saepe pilorum fasciculis in axillis nervorum. Inflorescentia ad 12 cm. longa, laxe ramosa, ramulis calycibusque sericeo-tomentosis.

The following specimens have been seen by me in Australian herbaria. The following abbreviations have been used to designate the source of the material cited:—B—Brisbane; M—Melbourne; S—Sydney.

R. Moorei F. Muell. *f. sericea.*

Queensland.—Springbrook, alt. 3,000 ft., brown loam soil, in rain forest, C. E. Hubbard, No. 4273 (flowers), 29th Sept., 1930 (rambling over shrubs and low trees) (B); same locality, J. E. Young (fruits), Dec., 1921 (B); Beechmont, alt. 2,000 ft., common on edge of rain forest, C. T. White, No. 6180 (flowers), 1st Sept., 1929 (vigorous vine, flowers white) (B); Candle Mt., C. T. White (B); Blackall Range, C. T. White (sterile material), April, 1918 (B—an intermediate form less sericeous than usual); Roberts Plateau, Lamington National Park, C. T. White (sterile material), Jan., 1919 (B—less sericeous than usual).

New South Wales.—Clarence River, C. Moore (M—type of the species); Lismore, Miss Rothwell, E. Cheel (M); Clarence River, Moore (fruit black of a sub-acid nature) (M); from the creek bank at Mt. Archer, Leichhardt (flowers), 23rd Sept., 1843 (M).

R. Moorei F. Muell. *f. glabra.*

Queensland.—Springbrook, alt. 2,000 ft., C. T. White (B); Roberts Plateau, Macpherson Range, C. T. White (B).

New South Wales.—Dorrigo State Forest, alt. 2,500 ft., common as secondary growth and on edge of rain forest, C. T. White, No. 7542 (flowers), 4th Oct., 1930 (B—type of the form); Upper Williams River, common in brush forests, C. T. White, No. 11484 (climber, leaves glossy

green, local name "Lawyer Vine") (B); Hastings River, F. Mueller (M); Scrub, near Tenterfield, Moore (M); Tweed River, Moore (M); Illawarra, A. T. Ralston (M); Brisbane Water, Moore (M); Blue Mountains, Miss Atkinson (M); creek bush, near Mr. Archer's, Leichhardt, 23rd Sept., 1843 (M); New England, C. Stuart (M); Burrawang, J. J. Fletcher (S); Gosford, Boorman (S); Cooramba, Boorman (S); near Pt. Macquarie, McDonnaugh (S); Clarence River, Beckler (S); Cambewarra Mt., J. H. Maiden (S); Mt. Kembla, A. G. Hamilton (S); Milton, R. H. Cambage (S); Hastings River, Forester Brown (S); Otford, S. C., J. H. Camfield (S).

Family CUNONIACEAE.

Ceratopetalum corymbosum sp. nov.

Arbor(?). Folia opposita, 3–foliolata; petiolus communis validus, 1·5–3 cm. longus; foliola sessilia, coriacea, lanceolata vel peranguste obovata, apice acuta vel plus vel minus abrupte et obtuse acuminata, basi cuneata, utrinque reticulata, margine subintegra (in specimine nostro valde undulata) in sicco anguste recurva, 4–10 cm. longa, 1·3–2·5 cm. lata. Paniculae terminales, corymbosae, ramis primariis 3, quadrangularibus, lateralibus ca. 6 cm. longis, medio 7–8·5 cm. longo; ramis secundariis et ramulis ultimis pedicellisque tenuiter pubescentibus; pedicellis vix 2 mm. longis. Calycis tubus 2 mm. diam. tenuiter pubescens, lobis 5, anguste lanceolatis, 5–6 mm. longis, 1·5 mm. latis, extus, glabris, intus ad margine lineam angustam minute tomentosum notatis. Petala 0 (?). Stamina 10, filamentis 3 mm. longis basin versus leviter dilatatis; antheris 0·75 mm. diam., connectivo in apiculam recurvam non producto. Discus subcarnosus, annulatus, lobatus. Pistillum glabrum.

Thornton Peak, alt. 4,500 ft. Dr. H. Flecker (flowers), 14th Dec., 1940. N.Q. Nat. Club, No. 7108.

The affinities of the present species lie with *C. Virchowii* F. Muell., but the two species can be easily determined as follows:—

Leaflets broadly lanceolate or elliptic, long acuminate, 6-8 cm. long, 2-3 cm. broad. Petiolules 1-2 cm. long. Inflorescences terminal and subterminal. Peduncle solitary .. .. .. *C. Virchowii.*

Leaflets narrowly lanceolate or very narrowly obovate, shortly acuminate, 4-10 cm. long, 1.3-2.5 cm. broad, sessile. Inflorescence terminal, main branches (peduncles) 3 .. .. .. *C. corymbosum.*

Family HALORAGACEAE.

Haloragis glabrescens sp. nov.

H. tetragyna (Labill.) Hook. var. *glabrescens* F. M. Bailey, Bot. Bull. XIII. (Dept. Agric. Brisbane), 9, 1896; Queensland Flora, 2, 556 (1900).

Herba vel suffrutex subprocumbens, caulibus numerosis simplicibus erectis vel arcuato-adscendentibus angulis decurrentibus lineato-alulatis glabris vel alulis pilis asperis brevis sparsissime obsitis. Folia alternantia, dense disposita, erecta vel suberecta, basi angustata, sessilia, lanceolata, serrata, dentibus remotis, margine minute setoso-serratula, 2–4 cm. longa, 4–8 mm. lata, glabra vel pilis brevis albis conicis asperis sparse obsita. Inflorescentia racemosa, 5–8 cm. longa. Flores hermaphroditi, in axillis foliorum superiorum in bracteas diminutorum axillis dichasium 4–1 florum constituentes, breviter pedicellati, pedicello 1–1·5 mm. longo, ad basim bracteolis 2 anguste lanceolatis munito. Calycis

tubus subglobosus dense et breviter pilosus, irregulariter tuberculatus, lobis 4, ovatis vel anguste triangularibus, 1 mm. longis. Petala 4 late lineari-navicularia, apice acutiuscula, 3–3·5 mm. longa et latere visa 0·5–1 mm. lata, glabra, carino minute asperulo-denticulata. Stamina 8, 2·5–3 mm. longa. Styli 4, glabri, erecti. Fructus subglobosus, 5–6 mm. diam., 4-locularis, induratus, breviter pilosus, processis duris applanatis vel varius teretibus irregulariter sed plus vel minus dense munitus, processorum apice saepe leviter expansus vel furcatus.

Queensland.—Burke District: Marathon Station, West of Hughenden, gully in *Astrebla lappacea* grassland, heavy dark brown soil, wet places in rainy season. C. E. Hubbard, 7770 (flowers), 17th Feb., 1931 (distributed as *H. heterophylla* Brongn. var. *glaucifolia* Schindl.). Flinders River, near Julia Creek, C. T. White, sine No. (fruits), Aug., 1916. Normanton, T. A. Gulliver (fruits), July, 1876. Gregory North District: Roxborough Downs, Georgina River, F. M. Bailey (young flowers), Dec., 1895. Diamantina River, Dr. T. L. Bancroft (flowers and young fruits), April, 1892. Elderslie, Winton, J. F. Kennedy (restricted to channels where it is very common and very prominent). Mitchell District: Landsborough River, C. T. White (type: flowers and fruit) (April, 1919). Muttaburra, C. T. White (fruits), April, 1919.

In its glabrous character, *H. glabrescens* is very near to *H. glauca* Lindl.; I have not seen authentic material of this species, but the fruits as described by Schindler in his monograph of the Halorragaceae (Engl. Pflanzenreich iv., 225, p. 45) are quite glabrous and irregularly tuberculate.

In the Herb., Kew, Bailey's *H. tetragyna* var. *glabrescens* had been placed under *H. heterophylla* Brongn. var. *glaucifolia* Schindl. and Hubbard's 7770 was distributed under this name. I have seen a duplicate of Koch's specimens from South Australia quoted by Schindler, and these differ in being pubescent and having ovaries far less tuberculate than in our plant. In a broad sense, *H. glabrescens* might be classed as a variety of *H. heterophylla* Brongn., but that species as understood by Schindler already I think includes several quite distinct ones. The present plant is very abundant in depressions and channels in the black soil plains of the tropical west of Queensland. The most characteristic feature is the dense covering of hard processes all over the fruits.

Family MYRTACEAE.

Acmena macrocarpa sp. nov.

Arbor glabra, 13 m. alta, ramulis junioribus acute quadrangulatis in parte superiore internodiorum valde dilatatis, internodiis 5–8 cm. longis. Folia anguste oblonga, supra nitida, nervis lateralibus in sicco utrinque leviter elevatis, in venam intramarginalem duplicem confluentibus, sed vena exteriore irregulari et saepe indistincta, interiore 5 cm. margine remota; lamina 16–20 cm. longa, 6–8 cm. lata; petiolo crasso 1 cm. longo, in sicco leviter ruguloso. Inflorescentia terminalis ca. 16 cm. longa, 8 cm. lata, pedunculis 7–8 cm. longis, basi teretibus, 2–3 mm. diam., in parte superiore angulatis, ramulis angulatis. Flores pedicellati, pedicellis 1 mm. longis; alabastris 4 mm. longis, 3 mm. diam., calycibus turbinatis, extus minute puberulis, basi stipitatis, calycis lobis minutis obtusis; petalis suborbicularibus 2 mm. latis extus minutissime puberulis; staminibus petala vix aequantibus. Infructiscentia robusta lignosa, ramulis ca. 1 cm. diam. Fructus globosus 6 cm. diam.

R.S.—Y.

Cook District.—Between Josephine and Russell Creeks, H. Flecker (type: North Queensland Nat. Club No. 4986), small tree 40 ft., flowers white. Russell Heads, F. R. Morris (North Queensl. Nat. Club No. 6429), fruits, 5th Nov., 1939 (tree 40 ft., fruit and branches ruddy).

Among previously described species closest to *A. divaricata* Merrill and Perry, which differs in having terete or slightly compressed branchlets, smaller leaves, and the inflorescence on short peduncles or nearly sessile. The fruit is very like that of *Cleistocalyx gustavioides* (Bail.) Merrill and Perry.

Type fragment and photograph at Herb., Kew, and Arnold Arboretum.

Agonis speciosa comb. nov.

Leptospermum speciosum Schauer ex Walpers, Repertorium Botanices Systematicae Tomus II., Supplementum I., p. 923, 1843. (*Agonis Scortechiniana* F. Muell. Fragm. Phytogr. Austr. XI., 118, 1881). *Melaleuca Leucadendron* L. var. *parvifolia* Benth. Fl. Austr. III., 143, 1866 (in part)).

Cunningham's plant (Moreton Bay, No. 38, 1824), the type of *Leptospermum speciosum* Schauer, is represented in Herb., Kew, by two sheets, and there is no question about its identity with *Agonis Scortechiniana* F. Muell., a shrub moderately common in South-east Queensland.

Eucalyptus camphora R. T. Baker in Proc. Linn. Soc. N.S. Wales XXIV., 298, 1899 (a large flowered form).

Darling Downs.—Racecourse Creek, N.E. of Wallangarra, on swampy flat between granite hills, L. S. Smith, No. 754, 29th Jan., 1940.

We are indebted to Mr. W. F. Blakely, the eminent authority on the genus *Eucalyptus*, for the determination. He remarks that the species had not previously been found north of Nullo Mountain, Rylestone, New South Wales.

Myrtus opaca sp. nov.

Frutex ad 2 m. altus, ramulis cortice griseo persistenti obtectis. Folia petiolata elliptica vel ovato-lanceolata, basi acuta, apice obtuse acuminata, utrinque glabra et opaca sed subtus distincte pallidiora, costa media utrinque distincta, nervis lateralibus invisibilibus vel obscuris, petiolo 2 mm. longo, lamina 2·5–3·5 cm. longa, 0·8–1·5 cm. lata. Pedicelli singulares, axillares, graciles, prominter lenticellati, 1·5 cm. longi; bracteolae subulatae, 1 mm. longae, pilis sericeis paucis obsitae. Calycis tubus late turbinatus, pilis longis sericeis dense obsitus, 2 mm. diam., lobis 5 utrinque sericeis 1·5 mm. altis. Petala 5 oblonga, 3 mm. longa, extus dense intus tenuiter sericea. Stamina numerosa, filamentis glabris petala aequantibus. Bacca ignota.

Wide Bay District.—Kandanga, Mary Valley, C. T. White, No. 9592 (flowers), Nov., 1933 (shrub up to 2 m. high, common on edge of rain forest, flowers white).

The closest affinities of the present plant lie with *M. dulcis* C. T. White. The two species can be distinguished as follows:—

Branchlets clothed with a reddish bark, deciduous in long slender threads. Leaves ovate to ovate-lanceolate, white or paler beneath, very acute; petiole 1 mm. long, blade 1.5-2.5 cm. long, 2.5-8 mm. broad. Pedicels slender, 3 mm. 1.1 cm. long .. .. .. *M. dulcis*.

Branchlets clothed with a grey persistent bark. Leaves elliptic or ovate-lanceolate, very opaque, paler beneath, obtusely acuminate, petiole 2 mm. long, blade 2.5-3.5 cm. long, 0.8-1.5 cm. broad; pedicels slender, 1.5 cm. long .. .. *M. opaca*.

Xanthostemon brachyandrus sp. nov.

Arbor glabra. Folia alterna, late lanceolata, apice acuta vel subacuminata, basi cuneata, lamina 12–18 cm. longa, 5–7 cm. lata, in sicco flavescens; petiolo crasso 0·5–1 cm. longo, in sicco atro-castaneo. Flores in thyrsos 3–6 cm. longos axillares et terminales dispositi. Calyx 5 mm. diam. sinuato-lobatus. Petala alba (Morris) vel in sicco flava, 6–7 mm. longa, 4–5 mm. lata. Stamina petala aequantia. Ovarium glabrum. Capsula ignota.

Cook District:—Mossman Gorge, H. Flecker (bud specimens), 3rd Nov., 1934 (N.Q. Naturalists' Club No. 292). Harvey Creek, F. R. Morris (type: flowering specimens), 19th Nov., 1939 (tree 40 ft., flowers white, fragrant).

Family UMBELLIFERAE

Torilis nodosa L. (Gaertn.) Fruct. i. 82, t. 20, fig. 6, 1788.

Darling Downs.—Cooyar, received from State School, Feb., 1939.

A native of Europe, not previously recorded as adventive in Queensland. Determination by Miss D. A. Goy.

Xanthosia diffusa sp. nov.

Suffrutex diffusus, dense pilosus, ramulis subrobustis. Folia tripartita vel rarissime simpliciter triloba, petiolata; petiolo 1–1·5 cm. longo; lamina supra viridi pilis longis albis sparsis vestita, subtus alba vel cremea densissime pilosa, segmento terminali 2–4 cm. longo, basin versus in petiolulum distinctum ad 1·5 cm. longum contracto, saepe trilobo et lobis ipsis 1–2–lobatis, segmentis lateralibus 1·5–3 cm. longis plerumque trilobatis basi cuneatis, subsessilibus vel in petiolulum ad 3 mm. longum contractis. Inflorescentia pedunculata, pedunculo communi 1–5 cm. longo, ad apicem sub radiis 2–bracteato, bracteis lineari-lanceolatis 6 mm. longis. Umbellae 3–4–radiatae, umbellulae 6–9–florae, pedicellatae, pedicellis 5 mm. longis. Involucrorum foliola 3, alba, petaloidea, ad 7 mm. longa et 4 mm. lata. Florum pedicelli 1 mm. longi. Calycis lobi ovati, 1 mm. longi. Petala 1·5 mm. longa, in parte inferiore in unguam contracta.

Moreton District.—Mt. Barney, alt. 1,000 m., C. T. White No. 11309, Sept., 1933 (type). S. L. Everist, No. 1373, 13th Oct., 1935 (intricately branched, subshrub, common in crevices of cliffs; flowers white, leaves pale green above, whitish tomentose beneath). Mt. Maroon, alt. 1,000 m., D. A. Goy and L. S. Smith, No. 705, 3rd Sept., 1939 (procumbent subshrub, flowers cream). Mt. Ernest, alt. 800–1,000 m., C. T. White,

sine No., 10th Oct., 1932 (subshrub of rather weak scrambling habit, flowers and bracts white). S. T. Blake, No. 4311, 10th Oct., 1932 (straggling shrub, flowers white). Lamington National Park, C. T. White, No. 11171, 22nd Oct., 1934 (straggling subshrub in rocky places bordering open forest).

The closest affinities with the present species lie with *X. pilosa* Rudge, under which name duplicates from the Queensland Herbarium had already been distributed. *X. pilosa* Rudge is a polymorphic species of which Domin Bibl. Bot. 87 (vi.), 1046-7, has already named four varieties. It varies considerably in leaf shape from simply pinnate or trilobed to ternately divided. The flowers vary from almost sessile to pedunculate in peduncles over 1 cm. The involucral bracts vary from inconspicuous to fairly large, but never so large as those of *X. diffusa*. The umbels are single and 1–4 flowered. In *X. diffusa* the inflorescence is composed of a 3–4–rayed umbel, each umbel consisting of 6–9 flowers. In this respect, it would come into the latter group of the "Flora Australiensis" (De Candolle's section Leucolaena) but differs in the absence of the sessile central cluster of flowers (umbellula).

Family RUBIACEAE.

Hodgkinsonia frutescens sp. nov.

Frutex, ramulis junioribus compresso-angularibus. Folia in sicco viridia, submembranacea, lanceolata vel elliptica, apice acuminata, basi cuneata in petiolum gradatim angustata, margine leviter undulato-denticulata, dentibus minutis distantibus, nervis lateralibus subparallelibus, nervis praecipuis 8–10 in utroque latere; petiolus ca. 1 cm. longus; lamina 8–13 cm. longa, 3–5 cm. lata. Flores in paniculas umbelliformes terminales dispositi; pedunculus communis gracilis 1–3·5 cm. longus, ramis secundariis pleurumque 5, 2·5–4 cm. longis; ramis ultimis 0·5–1·5 cm. longis sed floribus ipsis non in umbellulas veras dispositis. Calyx minutus, 4–5–lobatus. Corolla anguste campulata et 4–5–lobata vel urceolata et lobis indistinctis, extus glabra, intus dense pilosa, tubo 3 mm. longo, lobis 1 mm. longis. Stamina 4–5, exserta vel in floribus urceolatis inclusa, filamentis applanatis infra medium affixis, antheris dorsifixis 1·75 mm. longis. Ovarium glabrum, stylo profunde 2–lobato.

Cook District.—Atherton, A. L. Merrotsy (flowering Nov. and Dec.). Yungaburra, in rain forest, Dr. H. Flecker (flowers), 24th Dec., 1939 (bush, 4 feet high, flowers white).

The present is very closely allied to the only species previously known (*H. ovatiflora* F. Muell.), but is very distinct in general appearance. The two species can be distinguished as follows:—

Small tree, leaf-blades 5-8 cm. long, 1.5-3 cm. broad, papyraceous in texture when dry, margins entire, peduncle bearing 3 branches and no secondary ones .. .. *H. ovatiflora*.

Shrub, leaf-blades 8-13 cm. long, 3-5 cm. broad, submembranous in texture, margins distantly and minutely toothed, peduncle mostly bearing 5 main branches and often branched again .. .. *H. frutescens*.

Ixora orophila sp. nov.

Frutex (?) glaber, ramulis robustis apices versus dense foliosis. Folia coriacea elliptica vel late lanceolata, apice acuta basi cuneata, margine in sicco leviter recurva, nervis lateralibus supra vix visibilibus, subtus subobscuris, 4 in utroque latere, lamina 3–4 cm. longa, 1·3–2 cm.

lata, petiolo 3–4 mm. longo, stipulis interpetiolatis coriaceis deltoideis persistentibus, 2 mm. altis. Inflorescentiae cymosae, subterminales, folia aequantes, 5–9–florae, pedunculis 2–2.5 cm. longis, pedicellis 2–3 mm. longis. Calycis tubus anguste urceolatus, 2·5 mm. longus, limbo minute 5–dentato. Corolla 5–lobata, tubo urceolato, 2 mm. longo, lobis recurvis 4 mm. longis, ore barbato. Stamina 5, ore inserta. Discus pubescens. Pistillum ignotum. Fructus immaturus.

Cook District.—Thornton Peak, alt. 4,500 ft., Dr. H. Flecker, 14th Dec., 1940. N.Q. Nat. Club, No 7110.

The present species is quite different in general appearance from any other Australian species of *Ixora*. In its small coriaceous leaves and dense compact appearance, it is a typical mountain plant. The 5–merous flowers point to *I. pentamera* Benth. as the closest Australian ally, but this is much larger in all its parts, and very dissimilar in general appearance. In general facies, it approaches closer to *I. Beckleri* F. Muell., which differs in having larger, more prominently-veined leaves, a terminal larger and more spreading panicle, and 4–merous flowers.

Spermacoce auriculata F. Muell. Fragm. Phytogr. Austr. IV., 42, 1862.

Burke District.—Mt. Isa, alt. 1,250 ft., in open Eucalyptus forest in reddish-brown soil, C. E. Hubbard and C. W. Winders, No. 7408 (flowers), 9th Feb., 1931 (erect herb, green leaves, purplish corolla). Thirty-six miles from Mt. Isa on the Cloncurry-Mt. Isa road, on red stony country, S. L. Everist and L. S. Smith, No. 207 (flowers), 5th Feb., 1937 (small shrub with pale lilac flowers).

Not previously recorded for Queensland. Winders and Hubbard, No. 7408, distributed from Hb., Kew; Everist and Smith, No. 207, determined by L. S. Smith.

Family COMPOSITAE.

Arctotheca repens Wendland Botan. Beobacht., 41, 1798.

Darling Downs.—Toowoomba, R. B. Morwood (flowering specimens), Nov., 1940.

Determination by W. D. Francis.

A native of South Africa. The appearance of the plant is very similar to the Cape Weed (*Cryptostemma calendulacea* R. Br.) and it is likely to spread to about the same extent.

Arctotis grandis Thumb. Fl. Cap. 706, 1823.

A. stoechadifolia grandis Less. syn. Gen. comp. 26, 1832.

Maranoa District.—Roma, common in sandy soil along roadsides near the town.

C. T. White, No. 9431 (flowers), 29th Oct., 1933.

This plant is very common in garden cultivation in Queensland and seems to have become completely naturalised about Roma. It is very well illustrated in Addisonia, Vol. IV., 45, Pl. 143 (1919). In the text K. R. Boynton states, "This annual has been cultivated under the name *A. grandis*. Thunberg described it as a distinct species, and some later authors have called it merely a variety of *A. stoechadifolia*. There seem

to have been several forms of the species and perhaps that with long peduncled attractive flowers was brought to Europe for cultivation and the species described from it.''

Cassinia collina sp. nov.

Frutex 2 m. altus, ramulis subrobustis, dense fusco-hispidulis. Folia angustissime lanceolata, apice acuminata vel apiculata, basi angustata, supra sub lente minute asperula, subtus dense cano-tomentosa, margine revoluta, 3–7 mm. longa, 2–4 mm. lata. Inflorescentia multiflora pyramidalis ad 16 cm. longa et 10 cm. lata, plerumque ca. 10 x 8 cm., densa et compacta vel plus vel minus laxa et expansa. Capitula 7–flora. Involucrum 4 mm. longum, bracteis exterioribus atro-stramineis interioribus pallididioribus. Achenia (vix matura) pubescentia.

Burnett District.—Biggenden Bluff, common on talus slopes, C. T. White, No. 7681 (flowers), 17th May, 1931 (shrub 2 m., leaves whitish beneath, flower heads straw-coloured).

Among previously described species, *C. collina* is closest to *C. quinquefaria* R. Br., which differs in its more glabrous character, smaller and narrower leaves, and smaller, fewer-flowered capitula. The leaves of *C. collina* are similar to those of *C. longifolia* R. Br. and *C. compacta* F. Muell., both of which have corymbose, not pyramidal inflorescences.

Chthonocephalus pseudevax Steetz. in Pl. Preiss 1, 445.

Warrego District.—Gilruth Plains, near Cunnamulla, fairly common on hard red soil flats, associated with *Gnaphalodes uliginosum* A. Gray, S. L. Everist, No. 1645, 17th Sept., 1938.

A definite locality for this plant, which was recorded as occurring in Queensland by Mueller in the ''Second Systematic Census of Australian Plants'' and was included by Bailey in the ''Queensland Flora'' and the locality given as ''the interior towards Cooper's Creek.'' There are no Queensland specimens, however, either in the National Herbarium, Melbourne, or the Queensland Herbarium, Brisbane.

Erechthites prenanthoides D.C. Prodr. VI., 296, 1837.

Moreton District.—Roberts Plateau, Lamington National Park, C. T. White, Jan., 1919.

Not previously recorded for Queensland.

Helichrysum Becklleri F. Muell. ex Benth. Fl. Austr. III., 627, 1866.

This species is very common as secondary growth in the cooler rain-forest areas of South-east Queensland. The specimen from Cunningham's Gap (leg. C. J. Gwyther) recorded by F. M. Bailey in ''Queensland Flora,'' Vol. III., p. 840, as *H. cinereum* F. Muell. belongs here. The specimen from Killarney (leg. J. Wedd) recorded by F. M. Bailey l.c. VI., 2007, as *Cassinia denticulata* is also *H. Beckleri* F. Muell.

H. cinereum F. Muell. and *C. denticulata* R. Br. should be deleted from the Queensland Flora until authentic specimens have been collected.

Family STYLIDIACEAE.

Stylidium fissilobum F. Muell. Fragm. Phytogr. Austr. i., 154, 1859.

Cook District.—McLeod River, Dr. H. Flecker (flowers), 18th Sept., 1936. N.Q. Naturalists' Club, No. 2261 (herb, flowers white).

Determination by L. S. Smith. The species is well illustrated by Mildbraed in his monograph of the Stylidiaceae in Das Pflanzenreich IV., 278, p. 36, figs. 13, G.–J. Our specimen differs from his figure in that the posterior corolla lobes are united at the base for a little distance above the glands. In this connection, the present specimens approach *S. schizanthum* F. Muell., but possess the two opposite teeth above the middle of the column, a feature apparently unique in *S. fissilobum* F. Muell. The species has not previously been recorded for Queensland.

Family MYRSINACEAE.

Ardisia Bakeri comb. nov.

A. racemosa R. T. Baker in Proc. Linn. Soc. N.S.W. XXVII., 380. Pl. XVI., 1902, non *A. racemosa* Spreng. nec Mez.

This plant is common as a shrub in rain forests in Northern New South Wales, and on the mountains of South-east Queensland bordering the New South Wales border. Dr. Merrill (in. litt.) drew my attention to the fact that Baker's specific name was already preoccupied.

Family LOGANIACEAE.

Buddleia brasiliensis Jacq. f. Eclog. t. 158.

Moreton District.—Ashgrove, near Brisbane, spontaneous along the bank of a small creek. C. T. White and S. L. Everist (flowers), 6th Aug., 1934 (subshrub 4 ft., leaves greyish green, calyx greyish white. corolla yellow).

A native of South America, not previously recorded as naturalised; up to the present it does not show any tendency to spread very much.

Buddleia Lindleyana Fortune in Lindl. Bot. Reg. (1844), Misc. 25.

Darling Downs.—Toowoomba, D. A. Goy (flowers), 12th March, 1930 (small shrub, flowers lavender, looks like a cultivated plant running wild in paddocks).

Native of China, much cultivated in gardens. It has not previously been recorded as naturalised or subspontaneous in Queensland.

Gaertnera australiana sp. nov.

Frutex (?) ramulis subrobustis fistulosis, junioribus applanatis leviter contortis, cicatricibus stipularis interpetiolaris valde notatis. Folia subcoriacea, lanceolata, utrinque pilis albis sparsis leviter immersis (cystolith-like) obsita, apice obtuse acuminata, basi cuneata; nervi laterales ca. 13 in utroque latere; lamina 17–22 cm. longa, 7–10 cm. lata; petiolus in specimine typico ca. 1 cm., in speciminibus aliis ad 2·5 cm. longus. Inflorescentia terminalis 8·5 cm. longa, ramulis leviter contortis applanato-angulatis, ultimis minute tomentosis, bracteis ovatis 1 mm. longis. Flores sessiles. Calyx cupularis 2 mm. longus, 5–dentatus. Corolla 3 mm. longa, lobis tubo aequilongis, fauce dense albo-barbato. Antherae 1 mm. longae. Pistillum glabrum, stylo elongato-clavato, apice in lobos 2 lineares stigmatosos diviso. Fructus pisiformis, 5–6 mm. diam., 2–spermus.

Cook District.—Utchee Creek, in "jungle," Dr. H. Flecker (type: flowers), 27th Nov., 1938, N.Q. Nat. Club, No. 5313. Danbulla, in rain forest, Dr. H. Flecker (old flowers), 1st Jan., 1941, N.Q. Nat. Club, No. 7174. Bellenden-Ker, C. T. White, No. 1277 (fruits), March, 1922.

The genus is new for Australia. The Queensland plant comes into the group characterised by Ridley (Fl. Malay Penin. 2, 427) as "Thick-stemmed shrubs with large leaves." It seems to come closest to *G. grisea* Hook f., which differs in the branches, inflorescence, and under surface of the leaves being densely pubescent.

Family BORAGINACEAE.

Heliotropium filaginoides Benth. Fl. Austr. IV., 398, 1869.

Gregory North District.—Between Cluney and Currabulka Stations, on top of a low rock-capped hill, S. L. Everist and L. S. Smith, No. 108, 22nd Jan., 1937 (low, stunted, spreading herb from a woody base). Determined by L. S. Smith.

Burke District.—Cloncurry, on bare spots in *Triodia* country, usually on diorite ridges, fairly common, has no associates, S. E. Pearson, No. 116 (harsh, low growing plant, forming compact clumps 1–2 ft. diam., stolons often buried in self-collected dust and drift sand).

Not previously recorded for Queensland.

Family CONVOLVULACEAE.

Ipomaea quinquefolia L. Sp. Pl. 162, 1753.

Cook District.—Cairns, growing over a fence, H. Flecker (flowers), 14th May, 1937 (twiner, flowers cream-coloured). Same locality, in vacant allotments, H. Flecker, No. 2535 (flowers and fruits), 10th Nov., 1936 (scrambling over bushes, flowers pale buff).

A native of continental tropical America and the West Indies. Not previously recorded as naturalised in Queensland.

Ipomaea lonchophylla J. M. Black in Trans. and Proc. Roy. Soc., South Aus., 50, 285, 1926.

Mitchell District.—Darr River, C. W. de Burgh Birch. Blackall, S. L. Everist, No. 1594, 7th Feb., 1938. Malvern Hills, 22 miles west of Blackall, S. L. Everist, No. 2041, 5th March, 1940.

Maranoa District.—Roma, Rev. B. Scortechini.

Not previously recorded for Queensland. The plant is fairly common on downs country in Western Queensland. The specimens from Darr River and Roma were placed in the Queensland Herbarium under *I. heterophylla* R. Br.

Family SOLANACEAE.

Solanum capsicastrum Link ex Schauer in Otto & Dietrich Allgemeine Gartenzeitung 1, 228, 1833.

Moreton District.—Mudgeeraba, side of railway track at railway station, C. E. Hubbard, No. 4299 (flowers), 30th Sept., 1930 (up to 3 ft. high, leaves dull dark green, flowers white, anthers orange).

A native of South America, frequently cultivated on account of its compact growth and ornamental berries. It has not previously been recorded as naturalised in Queensland. Hubbard's plant was distributed by the Royal Botanic Gardens, Kew (Eng.).

Solanum coactiliferum J. M. Black in Trans. Roy. Soc., South Aus. XXXIII., 224, 1909.

Warrego District.—Gilruth Plains, near Cunnamulla, in deep sandy soil, not common, S. L. Everist, No. 1629, 17th Sept., 1938.

Species not previously recorded for Queensland. Determination by S. L. Everist.

Solanum pugiunculiferum n. sp.

Suffrutex glaber 30–60 cm. altus (Brass), ramulis foliis calycibusque aculeis robustis rectis armatis, aculeis flavis ad 1·5 cm. longis basi 2 mm. diam. Folia petiolata; petioli 2·8–5 mm. longi; lamina 2–4 cm. longa, 1–2·5 cm. lata irregulariter pinnatifida, lobis acutis 0·5–1·5 cm. longis, basi 3–8 mm. latis. Inflorescentia laterales racemosae 3–4 cm. longi; pedicelli ad 3 mm. vel sub fructu ad 8 cm. longi. Calyx late campanulatus 3·5 mm. longus, 5–dentatus, dentibus 1 mm. longis. Corolla clausa 6 mm. longa. Stamina prope basin affixa; filamenta 1·5 mm. longa; antherae 2·5 mm. longae. Bacca globosa ca. 1 cm. diam.; semina suborbiculata (2·75 × 3·5 mm.) late alata flava valde compressa.

Burke District.—Settlement Creek, L. J. Brass, No. 244 (flowers and young fruits), Nov., 1922 (subshrub 1–2 ft. high). Burketown, near the old meatworks, P. G. Higgins (fruits), 26th May, 1919.

The present species is very close to *Solanum xanthocarpum* Schrad. & Wendl., with which Hooker (Fl. Br. India IV., 236) unites the Australian *P. armatum* R. Br., particularly some of the Indian forms, but differs in being glabrous in all parts even to the corolla, and in the racemes being shorter.

Family AMARANTACEAE.

Ptilotus exaltatus Nees in Pl. Preiss. i., 630, 1845.

Trichinium exaltatum Benth. Fl. Austr. v., 227, 1870.

Trichinium Burtonii F. M. Bailey Bull. 7, Dept. Agric., Brisbane, 14, 1891 (sometimes quoted as Bot. Bull. 2).

Trichinium nervosum F. M. Bailey, Queens. Agric. Journ. xxv., 287, 1910.

This species is very widely spread in the tropical interior of Queensland. It is strange, however, that though it has a wide range in the other States, all the Queensland specimens in the Queensland Herbarium, Brisbane, are from the tropic of Capricorn northwards. In the south-west it is replaced by *P. nobilis* F. Muell.

Ptilotus Pearsonii sp. nov.

Herba perennis, 20–60 cm. alta, caulibus simplicibus vel in parte superiore ramosis, deinde sublignosis, caulibus foliisque dense lanuginoso-hirsutis. Folia lanceolata superiora sessilia, inferiora in petiolum distinctum gradatim angustata, apice mucronato-acuta, 2·5–7 cm. longa, 0·5–1 cm. lata. Spicae oblongae vel subglobosae deinde saepe nutantes vel horizontales, ad 8 cm. longae, ca. 5 cm. diam. Bracteae hyalinae, pallidae, glabrae (costa media excepta); costa prominens in acumen producta, extus tenuiter sericea; bracteolae bracteis similes sed angustiores. Perianthium 2 cm. longum, flavo-virens, tubo 5 mm. longo, pilis sericeis longis dense obsito, segmentis angustis peracutis extus (apice nudo excepto) plumosis, intus glabris. Stamina subaequalia, omnia fertilia. Pistillum glabrum.

Burke District.—Cloncurry, plentiful in Soldier's Gap area, found regimented on stony ridges, but frequents bare patches free of *Triodia,* S. E. Pearson, No. 112 (type: flowers), July, 1941 (1–2 ft. high, on two or three stems, known locally as "Tassel Top," eaten by horses and kangaroos). Cloncurry, alt. 800 ft., on stony to rocky quartzite hills among *Triodia pungens,* S. T. Blake, No. 10116 (flowers), 7th Nov., 1935 (stock woody, stems tufted, erect up to 2 ft., simple or branched, inflorescence inclined or distinctly nodding, green).

The present species would come under Bentham's Series Straminea (Fl. Austr. v., 218, sub *Trichinium*), and has most affinities with *P. nobilis* F. Muell. (*Trichinium nobile* Lindl.). The two species can be distinguished as follows:—

Glabrous or stems very slightly hairy in the upper part. Leaves broadly obovate to oblong, rarely lanceolate. Spikes terminal, erect, up to 15 cm. long. Bracts with a large dark centre, bracts and bracteoles hairy outside	*P. nobilis.*
Densely hirsute throughout. Leaves narrow-lanceolate. Spikes terminal, subglobose to oblong, up to 8 cm. long. Bracts hyaline throughout, bracts and bracteoles glabrous except for a few hairs on the midrib	*P. Pearsonii.*

Family CHENOPODIACEAE.

Chenopodium atriplicinum (F. Muell.) F. Muell. Fragm. Phytogr. Austr., 7th Nov., 1869.

Warrego District.—Clover Downs, Cunnamulla, R. Rice, No. 3, Aug., 1938.

Darling Downs.—Goondiwindi-Bungunya, R. Roe, No. 71, Sept., 1938.

Not previously recorded for Queensland. Determination by W. D. Francis.

Family EUPHORBIACEAE.

Baloghia marmorata sp. nov.

Arbor parva vel mediocris, ramulis novellis leviter complanatis mox robustis et tereticusculis. Folia petiolata integerrima glaberrima subcoriacea lanceolata vel obovato-lanceolata, apice acuta, basi angustata, venis et venulis in sicco utrinque prominulis, lamina 6·5–15 cm. longa, 2–5·5 cm. lata margine basin versus glandulis instructis; petiolo 2–4 cm. longo supra canaliculato basi incrassato apicem versus applanato; Bractae imbricatae, exteriores 2 cm. longae 4 cm. latae, interiores 6 mm. longae extus glabrae intus ad medium dense albo-sericeae margine albo-ciliolatae. Flores monoeci in racemos perbreves terminales dispositi; rhachi crassa. Flores masculi albi; pedicellis 5 mm. longis; sepalis 5 (?) ovatis, petalis 5 (?) lanceolatis; staminibus numerosis (ca. 40) receptaculo leviter elevato-affixis; filamentis 2·5–3 mm. longis basin versus pilis longis parcis albis vestitis; glandulis atro-purpureis (in sicco rubris) in discum lobatum carnosum plus vel minus connatis. Flos foemineus: pedicellis 1–1·5 cm. longis rectis vel curvatis apicem versus incrassatis; sepala petalaque non visa; ovario glabro, stylis 3 (raro 4) divisis vel raro indivisis. Capsula subglobosa 2 cm. diam., 3- vel 4-locularis in coccos 2-valvos unispermos dissiliens, seminbus ovoideis 1·5 cm. longis, extus irregulariter atro-rubro-maculatis.

Moreton District.—Tamborine Mountain, alt. 1,800 ft. (in rain forest on rich basaltic soils), C. T. White, No. 3588 (flowers and fruits), 17th Aug., 1927 (small or medium sized trees, flowers white).

Baloghia parviflora sp. nov.

Arbor mediocris glabra vel partibus novellis pilis parcis obsitis, ramulis subrobustis. Folia petiolata, subcoriacea, in sicco utrinque valde reticulata, lanceolata elliptica vel obovato-lanceolata, basi angustata, apice acuta vel obtusa; lamina 8–15 cm. longa, 3·5–7·5 cm. lata; petiolus 1·5–7·5 cm. longus, basi incrassatus. Inflorescentiae axillares racemosae, racemis axillaribus pedunculatis, rhachi cum pedunculo 2–6·5 cm. longa. Flores albi parvi in axillis bractearum superiorum 2–3 dispositi, bracteis inferioribus cassis (floribus delapsis?), pedicellis crassis 2–3 mm. longis ad apicem sub calyce 2-bracteolatis, bracteolis subcarnosis. Flos masculus: sepala 5 subcarnosa 3·5 mm. longa; petala 5 mm. longa, 2 mm. lata. Stamina ca. 15 in receptaculo elevata affixa, glandulis carnosis. Flos foemineus: Perianthium maris, ovario glabro, stylis 3 prope basin divisis. Fructus ignotis.

Cook District.—Bartle Frere, alt. 700 m. (common in foothill rain forests), S. F. Kajewski, No. 1251 (flowers), 1st Oct., 1929 (small tree up to 20 m., flowers white, stamens cream). Mt. Spurgeon, alt. about 3,000 ft. (common in rain forest), C. T. White, No. 10546 (type: flowering specimens), Sept., 1936 (medium-sized tree, flowers white). Mt. Lewis, T. Carr, 30th Jan., 1941 (N.Q. Nat. Club, No. 7283).

Euphorbia plumerioides Teysm. ex Hassk. Hort. Bogor. Descript., 1, 29 (1858).

Cook District.—Thursday Island (on the beach), F. M. Bailey, No. 115 (leaves only), June, 1897 (plant milky).

A native of the Philippine Islands and New Guinea. Though the Thursday Island specimens are in leaf only, there seems little doubt about the determination.

Euphorbia thymifolia L. Sp. Pl. 454 (1753).

Cook District.—Cairns (growing on footpaths), H. Flecker, No. 2683 (flowers and immature capsules), 16th Dec., 1936 (a prostrate herb).

A pantropical weed not previously recorded from Queensland. It will probably become equally abundant as the closely allied *E. prostrata* Ait.

Phyllanthus disticha (L.) Muell. Arg. in DC. Prodr. 15 (2), 413 (1866).

Cook District.—Mowbray River, in riverine rain forest, L. J. Brass, No. 2124 (fruits), 27th Jan., 1932 (stiff-branched tree 15 ft. high, wood pale and brittle, bark pale grey, lenticellate, raised in annular wrinkles close below insertion of branches; inflorescence on short spur branches in old wood, fruit depressed, 4-angled, succulent, greenish-white when ripe).

Not previously recorded as Australian; the habitat and locality indicate that it is a native and not introduced.

Family GRAMINEAE.

Agropyron pectinatum (Labill.) Beauv. Agrost. 102, 1812.

Moreton District.—Wilson's Peak, alt. about 2,500 ft., along steep mountain track on edge of rain forest. D. A. Goy and L. S. Smith, No. 385, 2nd May, 1938.

The species has not previously been recorded for Queensland. Our plant agrees well with that of Gunn, No. 999, from Tasmania, collected in 1857. The Queensland plant is apparently taller than the average of those in Tasmania. (Determination by L. S. Smith.)

Family POLYPODIACEAE.

Pellaea viridis (Forsk.) Prantl. in Engl. Bot. Jahrd. 3, 420, 1882. Moreton District.—Mt. French, E. J. Smith, March, 1940. A native of South Africa.

Mr. Smith, a keen local botanist, writes: "A native fern growing wild beside some large stones in a fairly sunny situation."

I thought at first the specimens represented a bipinnate form of *P. falcata* (B. Br.) Fee, but on closer examination, found they were identical with *P. viridis* (Forsk.) Prantl. This species is fairly common in cultivation in "bushhouses" in Queensland, and the spores must have been carried to the locality recorded by wind or other agency.

THE MIDDLE DEVONIAN RUGOSE CORALS OF QUEENSLAND, III. BURDEKIN DOWNS, FANNING R., AND REID GAP, NORTH QUEENSLAND.

By DOROTHY HILL, M.Sc., Ph.D., Department of Geology, University of Queensland.

PLATES V. TO XI.

(*Read before the Royal Society of Queensland, 27th October*, 1941.)

Summary.—In this paper twenty-three species of Rugosa, fifteen of them new, are described from the limestones of the Charters Towers and Townsville districts, with some discussions on the genera and families to which they are assigned. The fauna is very closely comparable to those of the upper Honsel (*quadrigeminus*) and Büchel (Massenkalk or *Amphipora* Bänke) beds of the Paffrath Basin near Cologne, Germany, so that its age is Givetian—and more narrowly, that middle section of the Givetian covered by the *quadrigeminus* and Büchel beds.

Some of the material described in this paper is in the Collection of the Geological Survey of Queensland, having been collected by various officers of that Survey. But the greater part, collected by Dr. F. W. Whitehouse or myself, is in the Geology Department of the University of Queensland. Collections have been made from the limestones at three different areas:—Burdekin Downs station, Fanning R. station, and the Reid Gap on the northern railway to Townsville.

At Burdekin Downs the limestones are impure and brown weathering, with some thick bands interbedded in a succession of thin (4 to 6 inch) layers. They overlie a massive quartzite, and have generally low dips, but are sometimes faulted, and in some places a granite shows up from beneath the basal quartzite.

On the Fanning R. from 1½ to 2 miles above Fanning R. homestead (location in 1939), the limestone is about 400 ft. thick, striking NNW-SSE, and dipping with a low dip (about 10°) WSW; it is fairly pure, and is grey to brown in colour. The succession observed was as follows, from above downwards:—

Sandstones with white clays up to 18 inches thick.

Shelly limestones (brachiopods and cephalopods).

Main coral and *Amphipora* limestone, about 400 ft. thick.

a. *Endophyllum-Stringophyllum isactis* beds, with very large *Atrypa*.
b. Beds with slender branching polyzoan.
c. Rather massively bedded limestones, in hard bands 4 to 6 inches thick, without shale partings, and with slight development of nodules; with *Stringophyllum bipartitum*, *Mesophyllum collare*, *Calceola* and *Atrypa*.
d. Two brown layers, with spherical weathering.
e. *Favistella rhenana* limestones, with many large stromatoporoids and a few *Stringocephalus*.

f. Yellow-weathering shale with gastropods (*Polyamma*).

g. Nodular limestones with *Favistella rhenana* and many *Stringocephalus*.

h. Nodular limestones with small pentameroids and Disphyllids.

j. *Amphipora ramosa* beds with small corals.

Intrusive granite.

Grey shales with limey concretions, and local transitions to nodular limestones with corals and stromatoporoids.

Limestones occur at various other localities on Fanning R. station, the distribution of the outcrops suggesting that they have been determined by faulting.

In the Reid Gap, on the northern Railway about 30 miles south of Townsville, there is another series of outcrops of this limestone, which appear to have been determined by faulting. The limestones here are grey to black, and are considerably metamorphosed, probably by contact metamorphism, as numerous porphyry dykes occur associated with them. They are rather more massive than on the Fanning R., and are of a very high degree of purity.

The lists of Rugose corals obtained from the various localities are as follows:—

Burdekin Downs.

(A) Burdekin Downs, hill rising from fowlyard. D. Hill Coll. 1939 *Acanthophyllum sweeti* rare; ?*Dohmophyllum* ?*clarkei* very rare; "*Cystiphyllum*" *australe* very common; *Disphyllum* (or *Macgeea*) *trochoides* very common; *Stringophyllum isactis*? rare.

(B) On the north side of the Burdekin R., within ¾ mile of Burdekin Downs homestead. J. H. Reid Coll. 1917. *Dohmophyllum clarkei*?, "*Cystiphyllum*" *australe*, *Disphyllum trochoides*, *D. excavatum*, *Favistella rhenana*.

(C) Arthur's Ck. R. L. Jack Coll. *Spongophyllum immersum*.

(D) Fence running North from the East end of the night paddock. D. Hill Coll. 1939. *Dohmophyllum clarkei* fairly common: "*Cystiphyllum*" *australe* common; *Disphyllum trochoides* common; *Stringophyllum irregulare* common.

(E) Anabranch of Burdekin R. near Big Rocks. D. Hill Coll. 1939. *Acanthophyllum sweeti* common; *Dohmophyllum clarkei* fairly common; *Yabeia salmoni* rare; *Calceola sandalina alta* fairly common; "*Cystiphyllum*" *australe* fairly common; *Disphyllum gregorii* fairly common; *Fasciphyllum ryani* rare; *Stringophyllum quasinormale* rare; *S. quasinormale* var. *ana* common.

(F) Limestone dam. D. Hill Coll. 1939. *Acanthophyllum sweeti* rare; *Dohmophyllum clarkei* common; *Lyrielasma*? *lophophylloides* fairly common; *Yabeia salmoni* rare; *Calceola sandalina sandalina* common; *Calceola sandalina alta* fairly common; "*Cystiphyllum*" *australe* very common; *Stringophyllum quasinormale* very common; *S. quasinormale* var.? rare; *Stringophyllum irregulare* rare.

Fanning R.

A.—Main coral and *Amphipora* limestone, Fanning R. from about 1½-2 miles above Fanning R. homestead. D. Hill Coll. 1939. See p. 229.

Bed A: Top of Fanning R. limestone. *Dohmophyllum clarkei* rare; *Calceola sandalina sandalina* operculum, non in situ; *Endophyllum abditum* var. *columna* common; *Stringophyllum bipartitum* rare; *S. isactis* common.

Bed C: *Dohmophyllum clarkei* common; *Calceola s. alta*; "*Cystiphyllum*" *australe* rare; *Mesophyllum collare* rare; *Stringophyllum bipartitum* common.

Beds E-G: *Acanthophyllum sweeti* rare; *Dohmophyllum clarkei* common; "*Cystiphyllum*" *australe* rare; *Disphyllum ?gregorii* rare; *D.* sp. (thick-walled) rare; *Favistella rhenana* common; *Grypophyllum* sp. rare; *Spongophyllum bipartitum?* rare.

Beds H-J: Base of Fanning R. limestone. *Dohmophyllum clarkei* common; *Lyrielasma curvatum* common; "*Cystiphyllum*" *australe* rare; *Disphyllum gregorii* common; *Disphyllum trochoides?* (with stereozone) fairly common; *Grypophyllum* sp. rare; *Stringophyllum quasinormale* rare; *Stringophyllum irregulare* rare.

B.—Fanning R. limestone, on road on left bank of Fanning R., about 1½ miles upstream from Fanning R. homestead. F. W. Whitehouse Coll. 1938. *Dohmophyllum clarkei* common; "*Cystiphyllum*" *australe* rare; *Favistella rhenana* common; *Grypophyllum* sp. *Stringophyllum bipartitum* common; *Calceola sandalina alta*, fairly common.

C.—Windmill, about 3 miles ESE of Fanning R. homestead. D. Hill Coll. 1939. "*Cystiphyllum*" *australe* common, *Disphyllum trochoides* common; this locality is probably on an identical horizon with the hill rising from Burdekin Downs fowlyard.

D.—Dome in Fanning R. near Cow paddock tank, Fanning R. station. D. Hill Coll. 1939. *?Dohmophyllum*; *Calceola sandalina sandalina*; "*Cystiphyllum*" *australe*; "*C.*" *pseudoseptatum*; *Mesophyllum* (*Dialithophyllum*) *fultum*; *Disphyllum ?*.

E.—Bauhinia limestone, on Mt. Success road 2½ miles from Fanning R. homestead. D. Hill Coll. 1939. *Dohmophyllum clarkei*; "*Cystiphyllum*" *australe*; *Stringophyllum bipartitum*.

F.—On Mingela road, 2½ miles from Fanning R. homestead. F. W. Whitehouse Coll. 1938. This is probably the same limestone outcrop as E. but the collection appears to have been made from a slightly different horizon, possibly lower. *Acanthophyllum sweeti*; "*Cystiphyllum*" *australe*; *Disphyllum gregorii*; *D. trochoides*; *Stringophyllum irregulare*; *Calceola sandalina alta*.

G.—Summit of hill about 2 miles North of Fanning R. homestead. F. W. Whitehouse Coll. 1938. *Dohmophyllum? clarkei*; *?Dohmophyllum* sp. "*Cystiphyllum*" *australe*; *?Disphyllum ?gregorii*; *D.* sp. (thick walls) *Favistella rhenana*; *Stringophyllum ?irregulare*.

REID GAP, on northern railway, 31 miles south of Townsville.

A.—Regan's Quarry (thought to have been in portion 397v parish of Magenta). E. Edelfelt Coll., probably about 1883. *Acanthophyllum sweeti*, *Dohmophyllum ?clarkei*, "*Cystiphyllum*" *australe*; *Disphyllum gregorii*; *D. trochoides*.

B.—Benwell's En. Selection. E. Edelfelt Coll. "*Cystiphyllum*" *australe*; *Disphyllum gregorii*; *D. trochoides*.

C.—Philp's. E. Edelfelt Coll. 1883. *Disphyllum gregorii*.

D. Ryan's Quarry, Calcium (portion 62v, parish of Wyoming). C. C. Morton Coll. *Favistella rhenana, Fasciphyllum ryani, Stringophyllum bipartitum.*

E.—Portion 370 parish of Magenta, lower bed. F. W. Whitehouse Coll. 1936. *Acanthophyllum sweeti; Dohmophyllum clarkei; "Cystiphyllum" australe* near *pseudoseptatum; Disphyllum ?gregorii; D. trochoides; Fasciphyllum ryani; Stringophyllum quasinormale; S. irregulare.*

30 ft. above lower bed. *Disphyllum excavatum.*

F.—Portion 54 parish of Wyoming. F. W. Whitehouse Coll. 1936. *Acanthophyllum sweeti; Dohmophyllum clarkei; "Cystiphyllum" australe; Disphyllum gregorii; D. trochoides?; Stringophyllum quasinormale.*

G.—Portion 81v, parish of Wyoming. Lower part of limestone. F. W. Whitehouse Coll. 1936. *Dohmophyllum clarkei; "Cystiphyllum" australe; Disphyllum* sp.; *Grypophyllum compactum; Stringophyllum irregulare.*

A study of the above lists show that their faunas are fairly uniform, although two species occur in only one locality, i.e., at the top of the limestone on the Fanning R. The following general list of the entire fauna shows the foreign species to which ours are most closely comparable.

Family Acanthophyllidae.

Acanthophyllum sweeti (Eth.) cf. *"Stenophyllum" diluvianum* Amans. from the Niederehe (Eifel) upper coralline limestone, and the *reticularis* marl at the base of *Stringocephalus* beds of Soetenich in the Eifel.

Dohmophyllum clarkei sp. nov. cf. *Sparganophyllum difficile, S. simplex, S. gracile* Wdkd. from the *quadrigeminus* beds of Hand, in the Paffrath Basin.

Lyrielasma curvatum sp. nov.

L. ? lophophylloides sp. nov. cf. *Cyathophyllum hallioides* Frech, crinoid beds, Dalbenden near Urft in the Eifel.

Ampleximorphs.

Yabeia salmoni sp. nov. cf. *Yabeia* from the Devonian of Yunnan, China.

Family Calceolidae.

Calceola sandalina sandalina Linn. from the *S. ostiolatus* beds (*Calceola* beds) of the Eifel, and lower part of *Stringocephalus* beds of Sauerland.

C. sandalina alta Richter from the *D. verneuili* beds of the Eifel, and middle part of *Stringocephalus* beds of Sauerland.

Cystimorphs.

"Cystiphyllum" australe (Eth.) cf. *Microplasma schlüteri* Wdkd. from the Upper Honsel beds of Emst, near Hagen, Germany; *Cystiphylloides* Yoh, lower Givetian of Kwangsi, China; *"Cystiphyllum" americanum* Ed. & H. *partim* from the Hamilton of New York.

"C" cf. *pseudoseptatum* Schulz from the upper coralline limestone of Niederehe in the Eifel.

Family Digonophyllidae.

Mesophyllum collare sp. nov. cf. (not very close to) some *Atelophyllum* Wdkd. from the upper Honsel beds of Emst, near Hagen, Germany.

M. (*Dialithophyllum*) *fultum* sp. nov. cf. *D. complicatum* Wdkd., topmost Honsel beds, Genna, Germany.

Family Disphyllidae.

Disphyllum gregorii (Eth.) cf. *C. caespitosum* var. *breviseptata* Fr. (?Plattenkalk), Refrath near Cologne, Germany; *D. emsti* (Wdkd.), Upper Givetian of Moravia.

D. (or *Macgeea*) *trochoides* sp. nov. cf. *D.* (or *M.*) *spongiosum* (Schl.), Büchel beds of Paffrath Basin; *D.* (or *M.*) *conicum* (Kett.), upper Givetian of Moravia.

D. (or *M.*) *excavatum* sp. nov. cf. *C. bathycalyx* Frech, 1886, pl. v, fig. 24 only, crinoid beds, Muhlberg in the Eifel.

Family Endophyllidae.

Endophyllum abditum E. & H. var. *columna* var. nov. cf. *E. colligatum* Eth., Middle Devonian of Tamworth, N.S.W.

Family Favistellidae.

Favistella rhenana Frech from the *quadrigeminus* and Büchel beds near Hand in the Paffrath Basin, Germany.

Fasciphyllum ryani sp. nov.

Family Spongophyllidae.

Spongophyllum immersum sp. nov. cf. *S. kunthi* Schl. and *S. parvistella* Schl., lower *Stringocephalus* beds of the Eifel.

Grypophyllum sp. cf. *G. normale* Wdkd., *quadrigeminus* beds of Hand, in the Paffrath Basin, Germany.

Grypophyllum compactum sp. nov. cf. *G. tenue* Wdkd., *quadrigeminus* beds of Hand, in the Paffrath Basin.

Stringophyllum quasinormale sp. nov. cf. *S. normale* Wdkd., *quadrigeminus* beds of Hand, in the Paffrath Basin; *Bornhardtina* beds of Soetenich in the Eifel.

S. quasinormale var. ?

S. quasinormale var. *ana* nov.

S. bipartitum sp. nov. cf. *S. büchelense* (Schl.), Genna, Germany [? upper Honsel].

S. irregulare sp. nov. cf. *S. tenue* Wdkd., Schwelm, Germany [? Massenkalk].

S. isactis (Frech) from the Büchel beds of Schladetal and Büchel in the Paffrath Basin; upper Givetian of Moravia.

The relationships may be summarised as follows:—

	Paffrath Basin.	Id.*	Comp.*	Altena Saddle.	Id.	Comp.	Eifel.	Id.	Comp.
Upper Middle Devonian = *Stringocephalus* beds = Givetian.	Plattenkalk Massenkalk = Büchel	2	1 1			1			
	Up. Honsel = *quadrig.*	1	4	Upper Honsel		4	Up. Coral 1st Crinoid beds		3 2

* Id. = Identical, Comp. = comparable species.

Thus there is a striking similarity to the fauna of the *quadrigeminus* beds of the Paffrath Basin near Cologne in Germany, and their German equivalents, and I consider that the bulk of the North Queensland limestones are roughly equivalent to the *quadrigeminus* beds of the Paffrath Basin. But on the Fanning R. at least, the top of the limestone probably equals some part of the succeeding Büchel beds (Massenkalk) of the Paffrath Basin, for it contains a species characteristic of the Büchel beds. The list also indicates a relation to the Chinese province. Only one species is comparable with the American Hamilton fauna. The study thus shows that the Burdekin, Fanning and Reid limestones are younger than the Murrumbidgee limestones of New South Wales, and the Clermont and Silverwood limestones of Queensland, all of which are considered to be Couvinian (Hill, 1939b, 1940a, 1940c).

SYSTEMATIC DESCRIPTIONS.

The descriptions given below are based on 524 thin sections and more than 1,000 specimens. It is noticeable that the individuals of many species, particularly those of the genera *Acanthophyllum*, "*Cystiphyllum*," *Disphyllum* and *Stringophyllum* could be divided into local races, from the morphological characters shown by them at the different localities. These races are not herein regarded as varieties, but are mentioned or described in the remarks on the species.

All genera described or named herein are interpreted on the genotypes given in Lang, Smith and Thomas, 1940, which should be consulted for references to the works in which the genera and their genotypes were founded.

FAMILY ACANTHOPHYLLIDAE.

Acanthophyllidae; Hill, 1939a, p. 220; 1939b, p. 56; Hill and Jones, 1940, p. 178.

Genus *Acanthophyllum* Dybowski.

Acanthophyllum Dybowski; Hill, 1939a, p. 222; 1939b, p. 56; Hill and Jones, 1940, p. 179.

Remarks: The genus as diagnosed in the references given above has wide limits, and as our knowledge of Devonian Rugosa becomes more soundly based, it may be found reasonable to split it. Thus there appears to be a distinctive morphological sub-group in the Givetian of Germany and Queensland, embracing the two species *Cyathophyllum sweeti* Etheridge and *Stenophyllum diluvianum* Amanshauser MS in Wedekind (1925, pp. 9, 12, text-figs. 3-4). These differ only in size and number of septa; the German species is about 28 mm. in diameter, with 34 septa of each order; but the Queensland species is smaller, up to 14 mm., with at most 28 septa of each order. In both, the septa are rather broadly waved in the dissepimentarium, and frequently show cymatoid carinae in the tabularium; the major septa are unequal and extend almost to the axis, without vortical curvature in the tabularium; dilatation of the septa occurs only near the epitheca. The calice is concave like an inverse cone, and the tabulae are very close. This sub-group is at present without a separate generic name, for although *S. diluvianum* is the genotype of *Stenophyllum*, this name is pre-occupied (see Lang, Smith and Thomas, 1940, p. 123). In this paper the sub-group is placed in *Acanthophyllum*. The cymatoid carinae of the septa and the arrangement of the axial ends of the major septa in the sub-group, where the cardinal or counter septum may frequently be longer than the others, are seen also in other genera regarded as

members of the Acanthophyllidae—the Silurian *Cymatelasma* and *Spongophylloides,* and the Devonian *Lyrielasma*; and in other species of the genus *Acanthophyllum—A. elongatum* and *A. dianthus* (Goldfuss), both described as Cyathophyllids by Le Maitre, 1934, from beds transitional between the Coblenzian and the Couvinian.

Acanthophyllum sweeti (Etheridge) Pl. V., figs. 1-5.

Cyathophyllum sp. ind. Etheridge, 1892, p. 59, pl. 3, figs. 11, 12; Regan's Quarry, Reid Gap.

Cyathophyllum sweeti Etheridge, 1895, p. 521, pl. xl., figs. 3, 4; pl. xli., fig. 1, Reid Gap.

Lectotype: on F 1652, Geological Survey of Queensland, from Regan's Quarry, Reid Gap, figd. Etheridge, 1892, *loc. cit.* Givetian.

Diagnosis: Acanthophyllum with about 26 septa of each order rather broadly wavy in the dissepimentarium, and somewhat dilated towards the periphery; the major septa are unequal and not vortically rotated, and may have cymatoid carinae in the tabularium; the cardinal or counter septum is frequently longer than the others.

Description: The corallum is trocho-cylindrical and probably solitary, and frequently somewhat vermiform. It may attain a diameter of 14 mm., in a height of 45 mm., but most corallites are fragmentary and rather slenderer. The epitheca shows narrow longitudinal septal furrows, and broad intervening ribs, all crossed by fine growth striation, and occasional growth constrictions. The calice is deeply oval like an inverse cone. The corallum is often somewhat oval in transverse section.

In the figured section of the lectotype, taken through the base of the calice, there are 26 septa of each order, but in most specimens the number is somewhat smaller. The septa dilate slightly in the outer parts of the dissepimentarium, gradually increasing till nearly at the epitheca, and then suddenly forming a narrow crenulate stereozone; the dilatation may spread over the upper surfaces of the outermost dissepiments. The minor septa are less dilated than the major septa. The septa are broadly and irregularly wavy, particularly near the epitheca. The major septa are unequal and usually fail to reach the axis, but in some corallites one may extend right to the axis; in one specimen at least this long septum is the counter septum, for its neighbouring minor septa are longer than the others. The major septa may have cymatoid carinae in the tabularium. The minor septa extend up to two-thirds of the way to the axis. The dissepiments are highly inclined and rather elongate, and the outermost series may be dilated. The tabular floors are thin and close, and concave, sometimes deeply so, or with a median notch, and are formed of numerous elongate tabellae.

Localities: Burdekin Downs, A,[1] E, F; Fanning R., A,F; Reid Gap, A (type locality), E,F.

Remarks: This species is almost identical with *A. diluvianum* (see p. 234) from the upper coralline limestone (*Cosmophyllum* beds) of Niederehe in the Eifel, which are at the top of the middle Middle Devonian of Schulz, i.e. near the top of the lower Givetian. Schmidt (1936, p. 317) has recorded *A. diluvianum* from the *reticularis*-marl at the base of the upper Middle Devonian of Soetenich in the Eifel. The only difference is that the Queensland species is smaller and has fewer septa than the German. The specimens from the type locality

[1] For explanation of localities referred to by letters see pp. 230-232.

are frequently slenderer than the type, while those from Burdekin Downs A (on the hill rising from the fowlyard) are somewhat stouter. Specimens from the anabranch of the Burdekin R. near Big Rocks (Burdekin Downs E) are on the whole much slenderer than those from the type locality, though some are stout, and many have recessive minor septa; this last character is so striking that it might prove better to regard the individuals showing it as a variety, but this is not done herein. Other specimens from this locality show a particularly strong development of cymatoid carinae. Specimens from Reid Gap E (portion 370 parish of Magenta) are very similar to those from the type locality.

Genus *Dohmophyllum* Wedekind.

Dohmophyllum Wedekind, 1923, pp. 29, 30; 1924, p. 76.

Trematophyllum Wedekind, 1923, pp. 27, 35 (genus caelebs); 1924, pp. 72, 75; genolectotype, chosen Lang, Smith and Thomas (1940, p. 135) *T. schulzi* Wedekind, 1924, p. 76, text-fig. 104, Lower Middle Devonian (lower coralline limestone), Niederehe, the Eifel.

Sparganophyllum Wedekind, 1925, p. 13; genoholotype *S. difficile* Borchers MS in Wedekind, 1925, pp. 13, 14, text-fig. 9; *quadrigeminus* beds of Hand near Bergisch Gladbach; and Pillingserbachtal, near Letmathe, Germany.

Genoholotype: D. involutum Wedekind, 1923, text-fig. 7 on p. 30; 1924, text-fig. 108. Crinoid beds (base of *Stringocephalus* beds), Auburg, near Gerolstein in the Eifel.

Diagnosis: Large, simple Rugose corals with a wide dissepimentarium of fine dissepiments, with numerous close, flattened tabellae arranged in irregular floors without a median notch, with long unequal major septa, sometimes slightly carinate, and with a vertical axial structure or an axial column of discrete, thickened, curved septal ends, often carinate.

Remarks: In my opinion the genera given in the synonymy should be merged, the distinctions made by Wedekind, on shape of calice, type of septal carination, and tightness of axial structure being considered of not more than specific value in this group. Together they characterise a relatively short period of time, from the top of the *Calceola* beds to the top of the lower part of the *Stringocephalus* beds of the German succession, and they are all covered by the diagnosis given above. The best known member of the genus is perhaps *D. helianthoides* (Goldfuss) from the crinoid beds of the Eifel. In its long, unequal septa and its close flattened tabellae the genus shows the characters of the Acanthophyllidae; but these tabellae are arranged in irregular groups, many of which appear to indicate irregularly domed tabular floors; and by this character they are separable from *Acanthophyllum*, which typically has regularly concave floors with a median notch. *Stenophyllum implicatum* Wedekind (1925, text-fig. 7) from the coralline crinoidal limestone (*Cosmophyllum* beds) of Dachsberg in the Eifel, appears to belong to the genus. Our Queensland species is closest to the German forms from the *quadrigeminus* beds of Hand in the Paffrath Basin.

Dohmophyllum clarkei sp. nov. Pl. V., figs. 6-11.

Holotype: F. 4531, University of Queensland Collection, base of Fanning R. limestone, about 2 miles upstream from Fanning R. homestead (1939). Givetian.

Diagnosis: Large trochoid or trocho-cylindrical *Dohmophyllum*, frequently with rejuvenescence; the axial ends of the long major septa are usually twisted in a moderately wide vertical axial structure; the minor septa are long and both orders are thin except at the periphery, where they suddenly dilate wedge-wise into a fairly narrow stereozone.

Description: The corallum is large and solitary, though usually associated with others of the same species; it is trochoid at first, tending to become cylindrical later; rejuvenescence may frequently cause a sudden decrease in diameter. It is often somewhat flattened. The holotype has a longer diameter of 28 mm. and a shorter diameter of 24 mm. at about 35 mm. from the apex, and is almost erect. Some coralla may be smaller, others much larger; one is 150 mm. long, with a longer diameter of 60 mm.; some may show slight curvature.

The average number of septa of each order is 28 or 30, but small corallites may show fewer, and large corallites up to 37 of each order (at a diameter of 46 mm.). The septa are thin, and usually without carinae, though some short, ragged trabecular carinae may occur on them near the inner margin of the dissepimentarium or in the tabularium. They expand suddenly wedgewise at the periphery, to form a stereozone; this is almost 1 mm. wide in the holotype; it tends to be widest near the apex, and thinnest near the calice. The septa are often somewhat wavy just inside the stereozone, and they may sometimes be discontinuous there. The major septa extend unequally towards the axis; typically many of them are strongly rotated in a counter-clockwise direction in the tabularium, thus forming a vertical axial structure, but they may be almost straight therein; sometimes they are somewhat withdrawn from the axis. The interseptal loculi in the tabularium are somewhat unequal. The septal ends may be somewhat thickened in the tabularium. In one specimen (F 4471) some of the septa are broken off from their axial ends which are twisted together irregularly, forming an axial column as in some *D. helianthoides* (Goldfuss). The minor septa extend nearly two-thirds of the way to the axis in the adult stages, rather less in younger stages, and more in very well developed coralla. The dissepiments are numerous and rather globose, but less so than in other species of the genus, and are steeply inclined. They are frequently geniculate in transverse section of the corallum. The tabular floors are usually irregular, sometimes sagging on one side and domed on the other. They are formed by numerous rather flattened tabellae, though occasional arched plates are seen, and are almost as closely spaced as the successive dissepimental floors. The width of the tabularium is variable, up to one-third the diameter of the corallum. The horizontal skeletal elements are consistently thinner than the septa.

Localities: Burdekin Downs A?, B?, D, E, F; Fanning R. A. (including type locality), B, D?, E, G?; Reid Gap A?, E, F, G.

Remarks: The queries in the locality list refer to specimens, from the locality cited, only doubtfully referred to *D. clarkei.* The species is close to individuals from the *quadrigeminus* beds of Hand in the Paffrath Basin, figured by Wedekind (1925) as *Sparganophyllum difficile, S. simplex,* and *S. gracile*; these have a similar number of septa and a similar external form, but the limits of variation in the German species are unknown. Our species varies within wide limits, and the chief variables are:—size of corallum, the number of septa taking part in the axial structure, the degree of the rotation of the axial ends and the degree to which these are discrete, and the width of the tabularium.

The dilatation and waviness of the septa vary slightly. The variation was not found to be of any strict significance geographically or stratigraphically.

Genus *Lyrielasma* Hill.

Lyrielasma Hill, 1939a, p. 243.

Genotype: Cyathophyllum subcaespitosum Chapman, 1925, p. 112, pl. xiii., figs. 15, 16a, b. Devonian, Cave Hill, Lilydale, Victoria.

Diagnosis: Fasciculate Rugosa with the major septa directed towards the median plane, with wide, deeply concave incomplete tabulae, and with a peripheral stereozone of irregular width, formed by the dilatation of major and minor septa in the dissepimentarium.

Range: Lower or Middle Devonian of Victoria.

Lyrielasma curvatum sp. nov. Pl. V., figs. 12-14.

Holotype: F 4423, University of Queensland Collection, base of Fanning R. limestone, Fanning R. about 2 miles above Fanning R. homestead. Givetian.

Diagnosis: Lyrielasma in which the axial ends of the septa may be vortically curved, and the tabulae may be horizontal or even slightly domed.

Description: The corallum is probably phaceloid, one section and some specimens showing corallites in such positions in the matrix as to suggest that smaller corallites arise from larger by lateral increase. The average diameter is 15 mm., and the corallites are cylindrical or slenderly trochoid, and may be erect or curved. Neither calice nor epitheca could be studied. There are about 25 septa of each order, dilated towards the periphery, so that a stereozone of irregular width is formed, varying from one corallite to another from 1 mm. to 4 mm. The major septa reach or almost reach the axis; they are unequal; sometimes they are arranged not very regularly about a median plane, but more often their axial ends are vortically curved. The dissepiments are small and steeply inclined, and are often geniculate in transverse section. The tabular floors are flat or gently domed or saucered, and are formed of numerous, close lying, flat tabellae.

Remarks: The species is placed somewhat doubtfully in *Lyrielasma* because its flat lying tabellae and the vortical curvature of its axial septal ends, which are not very distinctly arranged about a median plane, have not previously been observed in the genus. No foreign species is known to resemble it at all closely.

Lyrielasma (?) *lophophylloides* sp. nov. Pl. VI., figs. 1, 2.

Holotype: F 5129, University of Queensland Collection, Burdekin Downs, limestone dam. Givetian.

Diagnosis: Phaceloid Rugosa whose slender corallites have straight septa, with one longer and thicker than the others, highly inclined dissepiments and deeply concave tabulae.

Description: The corallum is phaceloid, with cylindrical corallites; increase is lateral. The corallites are about 9 mm. in diameter, and the nature of their epitheca and calice are not known. There is a narrow peripheral stereozone about 0·5 mm. wide, formed by lateral dilatation of the septal bases. There are 20 major septa extending unequally to the axis, all straight throughout their length; one, possibly

the counter or the cardinal septum, is longer than the others, and slightly thicker. One septum opposite to this, and two almost at right angles to it, may be but little shorter than it, and a little longer and thicker than the remaining septa. The 20 minor septa extend about two-thirds of the way to the axis. The dissepiments are equal and highly inclined. The tabularium is narrow and contains inversely conical, complete tabulae, rather distantly placed.

Remarks: It is doubtful that this species is of the genus *Lyrielasma*; it is provisionally placed therein because in the genotype the cardinal or counter septum is occasionally longer than the others, and the tabulae are inversely conical, and these are characters possessed by the new species. In internal structure it resembles very closely *Cyathophyllum hallioides* Frech (1886, p. 177, pl. xix., figs. 6, 6a, 15) from the crinoid beds of Dalbenden near Urft in the Eifel (that is, at the base of the lower part of the *Stringocephalus* beds of Germany); but the German species is solitary and has a wider dissepimentarium.

AMPLEXIMORPHS.

Ampleximorphs; Hill, 1940b, p. 390.

Solitary or fasciculate Rugose corals which have thin walls, short lamellar septa and complete tabulae, and are without dissepiments.

Genus *Yabeia*[1] Lang, Smith and Thomas.

Yabeia Lang, Smith and Thomas, 1940, p. 141, *nom. nov.* for *Cylindrophyllum* Yabe and Hayasaka, 1915, p. 90. *Cylindrophyllum* was pre-occupied in 1900.

Genoholotype: Cylindrophyllum simplex Yabe and Hayasaka, 1915, p. 90, and 1920, p. 133, pl. vi, figs. 3a-b; Devonian, neighbourhood of Hung-kuo-chi, Ta-kuan-ting, Chao-tung-fu, Province of Yun-nan, China.

Diagnosis: "Corallum composite, fasciculate; corallites long, erect, subparallel, only in contact at the point of gemmation; surface of the corallites transversely wrinkled and finely striated. No septa or septal spines at all. Tabulae complete, moderately close, horizontal. Multiplied by lateral gemmation."

Remarks: Owing to the complete absence of septa it must be questioned whether this genus is a Rugose coral, and it is placed rather doubtfully with the ampleximorphs.

Yabeia salmoni sp. nov. Pl. VI, figs. 3, 4.

Holotype: F 5025 University of Queensland Collection, Burdekin Downs station, on the anabranch of the Burdekin R. near Big Rocks. Givetian.

Diagnosis: Yabeia with distant tabulae.

Description: The specimens consist of numerous parallel or almost parallel cylindrical corallites, from 5 to 10 mm. in diameter, often crushed. Their manner of aggregation suggests that they are parts of a laterally increasing phaceloid corallum, but increase was not directly observed. The epitheca is transversely wrinkled and finely annulate, but no longitudinal striation can be distinguished. The wall is very thin, less than 0·25 mm. No septa or septal spines can be found. The tabulae are thin, horizontal and inequidistant, from 2 to 4 mm. apart. Walls and tabulae are usually lined with secondary calcite prisms.

[1] This name is pre-occupied by *Yabeia* Resser and Endo, 1935. See Neave's Nomenclator Zoologicus, Vol. IV., published in 1940.

Localities: In addition to the type locality, the species occurs on Burdekin Downs station at the limestone dam.

Remarks: Our form differs from the Chinese genotype in the greater distances between its tabulae. The absence of all traces of septa, either lamellar or spinose, is very striking; none are to be found even in tangential sections cutting obliquely into the lumen from the wall; nor are there any longitudinal striations on the epitheca such as usually correspond with septa. It thus differs from the German Givetian *Cyathopaedium,* for lamellar septa are well shown in Schluter's figures of his genotype. *Cyathopaedium* may be identical with the previously founded Silurian *Pycnostylus* Whiteaves (Hill, 1940b, p. 391). We have no information on the nature of the septa in another Devonian phaceloid ampleximorph, *Placophyllum* Simpson, from the Onondaga (Lower Middle Devonian) of North America.

FAMILY CALCEOLIDAE.

Family Calceolidae Lindstrom, 1883, p. 9, emended Hill, 1940b, p. 393.

Genus *Calceola* Lamarck.

Calceola Lamarck; Lindstrom, 1883; Richter, 1928, p. 174.

Genotype: Anomia Sandalinum Linnaeus, Germany.

Diagnosis: Calceoloid corals with semi-circular operculum; with the counter quadrants on the flattened side, and the cardinal on the curved side; the skeletal elements are so dilated that all interseptal loculi are filled up.

Remarks: Richter (1928) has concluded that the genus, which is characteristic of the Middle Devonian of Europe, Asia and Australia, but has not been recorded from America, contains one species only.

Calceola sandalina (Linnaeus).

Calceola sandalina (Linnaeus); Lindstrom, 1883, p. 10; Richter, 1928, p. 174.

Diagnosis: As for the genus.

Remarks: After statistical work on the variations in external form of German and other individuals, Richter (1928) has divided the species into four sub-species with range and characters as follows:—*Calceola sandalina* oldest mutation, occurs in the *cultrijugatus* beds at the base of the Couvinian in the Eifel, and in the lower Couvinian of Spain; the angle made by the edges of its flat side at the apex varies between 45° and 65°, but mostly between 55° and 62°. *Calceola sandalina sandalina* (see below). *Calceola sandalina alta* (see below). *Calceola sandalina westfalica* Lotze, occurs in the upper part of the Givetian of the German Sauerland, and at Muhlberg in the Eifel, in beds which were previously regarded as basal Givetian (Richter, 1928, p. 176); its angle varies between 50° and 75°, but mostly between 60° and 65°, and its sides are curved by a gradual broadening of the angle with growth.

Large, broad-angled and small, narrow-angled *Calceola* occur together in the North Queensland limestones, and appear to be referable on their external form to *C. sandalina sandalina* and *C. sandalina alta,* although my measurements of the average angle give in each case an increase of 5° to 10° on those given by Richter.

Calceola sandalina sandalina (Linnaeus) Pl. VI, figs. 5, 6.

Calceola sandalina sandalina (Linnaeus); Richter, 1928, p. 174.

Diagnosis: Large and broad *Calceola sandalina*, with apical angle between 50° and 80°, and usually between 60° and 70°.

Description of Queensland forms: The corallum is large, with a height of from 30 to 50 mm., and a breadth of from 50 to 60 mm. The apical angle varies from 70° to 90°, the average being about 80°. The flat (counter) surface is occasionally almost erect, but usually curves inwards during growth. The sides of the flat face are usually straight, so that the angle is constant throughout growth. The epitheca of the flat face shows a median ridge, and numerous ridges and furrows parallel to this. The calice is very deep, reaching almost to the apex. Vertical sections show that the sclerenchyme is deposited in successive growth lamellae.

Localities: Burdekin Downs F; Fanning R. D.

Remarks: The Queensland specimens agree with the descriptions of the German subspecies, except for the somewhat wider angle in our forms. In Germany the subspecies occurs in the *ostiolatus* (= *Calceola*) beds and in the lower part of the *Stringocephalus* beds.

Calceola sandalina alta Richter. Pl. VI, figs. 7-9.

Calceola sandalina alta Richter; Richter, 1928, p. 175.

Diagnosis: Small and narrow *Calceola sandalina*, with apical angle between 35° and 60°, and usually between 40° and 45°.

Description of the Queensland forms: The corallum is small, with a height of from 14 to 25 mm., and a breadth of from 10 to 21 mm. The apical angle varies between 35° and 60°, but most individuals are between 45° and 55°. The flat (counter) surface is often erect, but is more often slightly curved inwards. The sides of the flat face are usually quite straight. The calice is very deep, extending almost to the apex.

Localities: Burdekin Downs E, F; Fanning R. A, B, F.

Remarks: The Queensland specimens, like those of *C. sandalina sandalina* are preserved in bedded limestones, and do not weather out, so that it is difficult to measure their apical angle accurately. Our specimens appear to have a wider angle than the German. In Germany the subspecies occurs in the beds with *Dechenella verneuili* in the Eifel, and in the middle part of the *Stringocephalus* beds on the right side of the Rhine.

CYSTIMORPHS.

Cystimorphs; Hill, 1939a, p. 248.

Wedekind and Vollbrecht (1931) have considered that the cystimorphs of the lower part of the German *Stringocephalus* beds which are usually included in *Cystiphyllum pseudoseptatum* Schulz are of the same family as *Arcophyllum*, *Hemicystiphyllum* etc., and have described the family as the Lytophyllidae (i.e., Lithophyllidae). The character which they considered diagnostic of this family is the "septal cone." In *C. pseudoseptatum* and similar forms the septa are visible only as septal remnants in successive zones of skeletal dilatation; each zone of dilated tissue is deposited on one old calical floor, and thickens the dissepiments and tabulae at this position; the dilatation is greatest in the middle of the floor, and decreases towards the periphery; as the calical floor is conical in all these forms, the zone of dilatation is conical also. These successive zones of skeletal dilatation, as the present author

prefers to call them, rather than "septal cones," seem to her to represent successive zones of internal structural rejuvenescence, such as were suggested by Lang (1909, p. 290); while Ma (1937, p. 8) has considered that they represent the internal structural accommodation of the skeleton to annual seasonal changes. If they represent rejuvenescence, they would be very striking in forms whose young and old developmental stages are unlike, e.g., where the young stage has numerous thick septa, and the old stage no septa at all. In forms on the other hand where there is little difference between the septa of the young and the old stages, the difference would be least noticeable, and the zones of rejuvenescence might easily escape observation. These zones are important in "*C.*" *pseudoseptatum*, but are much less important in *Mesophyllum*, though they do occur in this genus as in other Rugosa. They do not seem to be a satisfactory criterion for a family.

I have preferred to group the cystimorphs *Arcophyllum*, *Hemicosmophyllum* etc. as possible sub-genera of *Mesophyllum* (see below p. 245), and because these forms all have an elongate minor septum in the counter fossula, I have included them in the Digonophyllidae (see p. 244).

The remaining cystimorphs of the lower part of the German *Stringocephalus* beds including "*C.*" *pseudoseptatum* have been considered by early authors under *Cystiphyllum* and *Microplasma*, while lately Wedekind, and Wedekind and Vollbrecht have used *Microplasma*, *Lithophyllum*, *Paralithophyllum*, *Nardophyllum* and *Plagiophyllum*. *Cystiphyllum* was founded for Silurian cystimorphs, which have discrete trabeculae preserved as holacanths, and holacanths have not been observed in any Givetian cystimorphs. *Microplasma* has for genotype a Silurian fasciculate cystimorph from Gotland, whose internal structure is insufficiently known for exact taxonomy in such a difficult group as the cystimorphs. *Lithophyllum* and *Nardophyllum* (= *Plagiophyllum*) have for genotypes forms in which the tabularium is not central, but is near or at the wall. Wedekind and Vollbrecht have shown that the position of the tabularium, while usually almost central, is variable in the group about *C. pseudoseptatum*, and it may be that it is not of generic value in the cystimorphs. The genotype of *Paralithophyllum* has not been figured.

Thus there is at present no satisfactory solution of the taxonomic problem of those Devonian cystimorphs which never show traces of the long counter minor septum of the Digonophyllidae. Such a solution must be based on a re-study of the German forms, since the great majority of the generic names have been applied to these; but this is not possible at present, and in this paper "*Cystiphyllum*" is used. Some, indeed, may have been derived from the Digonophyllidae, and for such the name *Cystiphylloides* Yoh (1937, p. 53) is available; but at present we have no certain means of distinguishing them.

The position of the cystimorphs of the lower *Calceola* beds of the Eifel, divided by Wedekind (1924) among *Zonophyllum*, *Legnophyllum* and *Pseudophyllum* must remain in doubt until their characters can be more clearly established. From the figures alone it appears that they could belong to the Digonophyllidae or to the cystimorphs like "*C.*" *pseudoseptatum*.

"*Cystiphyllum*" *australe* Etheridge (Pl. VI, figs. 10-13.)

Cystiphyllum americanum Edw. and Haime, var. *australe* Etheridge, 1892, p. 58, pl. iii, figs. 13, 14.

Lectotype (here chosen) on F 1652, Geological Survey of Queensland Collection, Regan's Quarry, Reid Gap; Givetian.

Diagnosis: Cylindrical cystimorphs typically without successive zones of skeletal dilatation, and with traces of trabeculae typically confined to a very narrow peripheral stereozone.

Description of the lectotype: The corallum is cylindrical and curved, with a maximum diameter of 28 mm.; the lectotype is 110 mm. long and incomplete, and in its distal parts shows rejuvenescence by which the diameter is reduced; this rejuvenescence breaks the epitheca at only one position, that of the thin section figured, and is not associated with skeletal dilatation. There is a peripheral stereozone about 1 mm. wide, in which short trabeculae may be counted indicating between 80 and 100 septa, presumably including both minor and major. The trabeculae may extend about 0·5 mm. into the lumen, and may be repeated on the first series of dissepiments, but none are seen inside this. The tabularium occupies almost one half of the lumen, and its plates are much larger than those of the dissepimentarium; they are arranged in concave tabular floors, and those which are the more inclined (the outer) are inflated in their upper parts. The tabularium is not quite central in the thin section figured. The plates of the dissepimentarium are smaller, more steeply inclined and less globose than those of the tabularium; they are not dilated; rarely they are inflated in their upper parts. Apart from the peripheral stereozone, there are no zones of skeletal dilatation.

Localities: Burdekin Downs A, B, D, E, F; Fanning R. A, B, C, D, E, F, G; Reid Gap A (the type locality), B, E, F, G.

Remarks: This is the commonest species in the north Queensland Givetian limestones. The tabularium is nearly always almost central. There is considerable variation from locality to locality, particularly in size. At the type locality, only a few specimens have a diameter greater than 28 mm., others are smaller. Those collected from the nearby portion 54 Wyoming (Reid Gap F) in large numbers have an average diameter of 16 mm. only, but in internal structure they are indistinguishable from the lectotype. They are mostly somewhat worn, and some thus show the long thickened bases of the septa; those weathered a little more may show long rows of dots representing the inner ends of the trabeculae. They show little curvature. One has a talon, probably indicating that the species is haploid (solitary). Specimens from Burdekin Downs, on the hill behind the fowlyard (A), are very close to the lectotype, but some show zones of skeletal dilatation, which may be very slightly or moderately developed. Others have rather larger dissepiments which are also more inflated in their upper parts. Specimens from the fence running N from the E end of the night paddock (Burdekin Downs D) are practically identical with the lectotype, though larger and smaller coralla occur. Some from the limestone dam on Burdekin Downs (F), where the size is usually greater, show larger dissepiments than the lectotype, which are also more swollen distally, so that circular sections are seen in transverse sections of the corallum; and this variation is yet more pronounced in specimens from the anabranch of the Burdekin R., near the Big Rocks (E); when the peripheral stereozone in such forms is very thin, one may imagine a relationship to *Mesophyllum*. Specimens from the Fanning R. show all the above variations, but on the whole they are larger.

This species is perhaps closest in internal structure to "*Cystiphyllum*" *schluteri* (Wedekind) from the upper Honsel beds of Emst, Germany, i.e. at the top of the lower part of the German *Stringocephalus* beds. Those specimens of "*Cystiphyllum*" *americanum* from the Hamilton (Givetian) of America, which have very little skeletal dilatation are also close, and may be related, as suggested by Etheridge. Some of the slenderer specimens of our species resemble *Microplasma fongi* Yoh from the lower Givetian beds Kwangsi, China, although Yoh's figures (1937, pl. iv, figs. 4-6) do not show a peripheral stereozone. Yoh's *Atelophyllum* (*Cystiphylloides*) *kwangsiense* from the same place resembles some of the larger specimens placed in "*C.*" *australe* herein, in the absence of skeletal dilatation; but Yoh's figure (pl. v, fig. 3a) shows long septal trabeculae not observed in any of the Queensland specimens.

"*Cystiphyllum*" cf. *pseudoseptatum* Schulz. Pl. VII, figs. 1a, b.

A specimen from the dome in the Fanning R. near the tank in the cow paddock shows great skeletal dilatation in successive zones, and thus suggests comparison or identity with "*C.*" *pseudoseptatum* Schulz (1883, pl. xxiii, figs. 3, 4) from the upper coralline limestone (lower part of the *Stringocephalus* beds) of the Hillesheim Basin in the Eifel, and with "*C.*" *americanum* Edw. & H. (Fenton and Fenton, 1938). Specimens from Burdekin Downs, on the hill behind the fowlyard, and from portion 370, parish of Magenta in the Reid Gap, appear intermediate in internal structure between it and the lectotype of "*C.*" *australe*. The Fanning specimen is turbinate.

FAMILY DIGONOPHYLLIDAE.

Typical Genus, *Digonophyllum* Wedekind.

Large, solitary Rugosa with a greatly lengthened minor septum in the counter fossula, with concave tabular floors of rather globose tabellae, and a wide dissepimentarium of smaller, globose dissepiments. The number of septa is large, and the septa are very variable in development. They may extend from periphery to axis, or they may be withdrawn from periphery or from axis or from both, leaving only occasional traces; they may be dilated in the tabularium or at the periphery, and the dilatation may proceed from the tabularium into the dissepimentarium; yard-arm carinae may develop on the septa or instead of them near the periphery; lateral dissepiments may buttress the septa. The septal development is often strengthened, at different calical floors, both in thickening and trabecular continuity.

Remarks: The family is very important in the Middle Devonian of the Eifel, and good figures of many of its members are given by Wedekind (1921, 1924, 1925), Vollbrecht (1926), Walther (1928) and Wedekind and Vollbrecht (1931). It appears to me to be divisible into two major groups, in one of which the septa are strongly developed, while in the other they are reduced in many ways. These groups contain the following genera from the German Devonian, each interpreted on the genotypes listed in Lang, Smith and Thomas (1940). First group: *Digonophyllum* and *Zonodigonophyllum* from the Nohn beds at the base of the *Calceola* beds of the Eifel, *Mochlophyllum* from the crinoid beds at the base of the *Stringocephalus* beds of the Eifel, *Pseudocosmophyllum* from the upper coralline limestone of Niederehe in the lower part of the *Stringocephalus* beds of the Eifel, and *Enteleiophyllum* from the ?upper part of the *Stringocephalus* beds of

the Sauerland. To these may be added *Uralophyllum* Sochkina from the Middle Devonian of the Northern Urals. These all show long and moderately persistent major septa, but in some the minor septa are impersistent with the exception of the one long one in the counter fossula, which is characteristic of the family. Second group: *Bothriophyllum* from the top of the *Calceola* beds of Heiligenstein in the Eifel, *Lekanophyllum* from the crinoid beds of Auburg at the base of the *Stringocephalus* beds of the Eifel, *Hemicystiphyllum*, *Hemicosmophyllum* and *Arcophyllum* (= *Cosmophyllum*, preoccupied) from the lower part of the *Stringocephalus* beds of the Eifel, *Mesophyllum* and *Atelophyllum* from Berndorf and the upper Honsel beds of Emst respectively, near the top of the lower part of the *Stringocephalus* beds, and *Dialithophyllum* from the top of the upper Honsel beds of Genna in the Altena saddle. In this group the septa are reduced in various ways, but it is nearly always possible to find the characteristic elongate counter minor septum of the family.

In both groups it is very difficult to evaluate species and genera, and it is possible that many of the genera in each group should be merged. For the purposes of this study each group is regarded as a genus (*Digonophyllum* and *Mesophyllum*), consisting of the sub-genera as named.

It is possible that some of the lower Givetian cystimorphs remarked above on p. 241 have been derived from members of the Digonophyllidae, by total suppression of the septa, i.e. as endpoints of the trends in septal reduction characteristic of the Digonophyllidae. Or, it may be possible, as Wedekind has suggested, that forms with well-developed septa have evolved from forms without septa. Many of the morphological groups distinguished by Wedekind show successive zones of skeletal dilatation, and these Wedekind considered diagnostic of the family Lithophyllidae. But (see p. 242) the present author considers these to be the result of internal structural rejuvenescence, such as is found in greater or less degree in all Rugosa.

The family is common in the Middle Devonian of Europe; it also occurs in Western Siberia and the Transcaucasus. In the Australian Middle Devonian some mesophyllids occur, but none of the group with well-developed septa, and the same appears to be the case in N. America.

Genus *Mesophyllum* Schlüter.

Mesophyllum Schlüter, 1889, p. 325.

Genolectotype (chosen Wedekind, 1925, pp. vii, 28, 38):—*Mesophyllum defectum* Schlüter, 1889, p. 333, pl. vii, fig. 2 (re-figured Wedekind, 1925, pl. 13, fig. 76). Upper Middle Devonian, Eifel, and Berndorf, near Hillesheim, the Eifel.

Diagnosis: Digonophyllids in which the septa are discontinuous and greatly reduced.

Remarks: Wedekind's figure of Schlüter's specimen shows the long minor septum in the counter fossula which is characteristic of the Digonophyllidae. It also shows considerable septal reduction, in that the axial ends of the septa are withdrawn from the axis, while their peripheral ends are replaced by discontinuous cross-bars, and their median segments are often discontinuous. The minor septa are more reduced than the major. The remaining septal segments are moderately thin. The various morphologies within this genus, see above p. 245,

distinguished with generic names by Wedekind and his co-workers, show different degrees of such septal reductions; the groups *Arcophyllum* and *Hemicosmophyllum* show only those types of reduction found in *M. defectum*, and in *Atelophyllum* these are carried further in the absence of the zone of peripheral, discontinuous cross-bars. In *Bothriophyllum*, *Hemicystiphyllum* and *Dialithophyllum*, peripheral reduction of the septa is slight, and cross-bars do not occur; but a different type of septal reduction, by which lateral dissepiments line the septa, characterises all three. In *Lekanophyllum*, although there is peripheral and axial withdrawal of the septa, there are no cross-bars, and no lateral dissepiments, but the septa may be reduced to a series of cylindrical trabeculae, frequently isolated one from another. The systematic value of these names is doubtful, but in the present paper they are given sub-generic rank. In the German Devonian all of these sub-genera occur in the lower part of the *Stringocephalus* beds of the Eifel, or in the upper Honsel beds of the Altena saddle.

Mesophyllum collare sp. nov. Pl. VII, figs. 2a, b.

Holotype: F 4395, University of Queensland Collection, bed *c* near the top of the Fanning R. limestone, on Fanning R. about 1½ miles upstream from Fanning R. homestead. Givetian.

Diagnosis: Large *Mesophyllum* in which the septa are completely withdrawn from both axis and periphery, leaving a collar of major and minor septal segments near the inner margin of the dissepimentarium; cross-bars are not developed.

Description: The corallum is very large. One fragment has a diameter of 80 mm., and another of 60 mm. The material available shows neither calice nor epitheca, due to weathering. At a diameter of 60 mm. there are segments of 55 major septa and 55 alternating minor septa, developed in a collar in the dissepimentarium, about half-way between the periphery and the axis. The segments may be up to 8 mm. long, and are dilated. Small wedge-like septal crests may be traced beyond each segment, on the upper surfaces of the dissepiments, both towards the periphery and towards the axis, but none of these crests are in the form of cross-bars. There is a wide peripheral zone of lonsdaleoid dissepiments, and a similar but narrower zone occurs at the inner margin of the dissepimentarium. In vertical section the dissepiments are rather steeply inclined, and somewhat globose in their upper parts; they are slightly thickened in successive zones representing some of the past positions of the calice. The tabularium is about 12 mm. wide, and contains rather large tabellae, arranged in concave tabular floors. The tabellae are much less steeply inclined than the dissepiments.

Remarks: None of the specimens figured by Wedekind or his co-workers show exactly this combination of the various types of septal reduction, but some *Atelophyllum* from the upper Honsel beds of Emst in the Altena saddle are fairly close, lacking only the segments of minor septa.

Subgenus *Dialithophyllum* Amanshauser emend. Wekekind.

Dialytophyllum Amanshauser MS emend. Wedekind, 1925, p. 40.

Genotype: D. complicatum Amanshauser MS in Wedekind, 1925, p. 40 p 43, text-fig. 63, topmost Honsel beds, Genna, Germany.

Diagnosis: Mesophyllum with septa withdrawn from the tabularium but continuous in the dissepimentarium, where also they may be buttressed by lateral dissepiments.

Mesophyllum (*Dialithophyllum*) *fultum* sp. nov. Pl. VII, figs. 3, 4.

Holotype: F 4535, University of Queensland Collection, Fanning R., by the cow paddock tank, Fanning R. station. Givetian.

Diagnosis: Mesophyllum with the septa (50 of each order) withdrawn from the axis but not from the periphery, and buttressed by lateral dissepiments.

Description: the corallum is large and trocho-cylindrical, with a diameter in the holotype of 40 mm. The epitheca shows growth annulation and longitudinal striation; the calice is filled with matrix in the three available specimens. At 38 mm. diameter there are 50 major septa extending a little over half way to the axis, and 50 alternating minor septa nearly half this length. The dissepimentarium is as wide as the length of the major septa. All the septa are buttressed by small lateral dissepiments, which inosculate with the normal dissepiments. The septa may be discontinuous just at the periphery and are then represented by discrete, cylindrical or sometimes cross-bar trabeculae. One minor septum, nearly opposite the cardinal fossula, is as long as the major septa. The dissepiments are geniculate in transverse section of the corallum. In vertical section the wide dissepimentarium is seen to consist of small, numerous and fairly steeply inclined plates, while the tabularium contains larger and fewer tabellae, arranged on concave tabular floors. The horizontal elements are dilated in successive zones, representing different positions of the calical floor during growth of the corallum.

Remarks: The species resembles the genotype of *Dialithophyllum* but has many more septa, with also fairly well developed minor septa. The genotype occurs in the topmost Honsel beds of the Altena saddle, in western Germany. These are usually regarded as the very top of the lower part of the German *Stringocephalus* beds.

FAMILY DISPHYLLIDAE.

Disphyllidae; Hill, 1939a, p. 224.

Genus *Disphyllum* de Fromentel.

Disphyllum de Fromentel; Lang and Smith, 1935, p. 554; Hill, 1940b, p. 398.

Remarks: It would appear from the figures that the genotypes of the genera *Megaphyllum*, *Peneckiella*, *Pseudostringophyllum* and *Diplophyllum*, all proposed by Soshkina (1939) for fasciculate forms from the Upper Devonian of the Urals, might well be species of *Disphyllum* as understood by Lang and Smith. *Megaphyllum* was preoccupied in 1894 for a myriapod, and *Diplophyllum* in 1851 for a coelenterate.

Disphyllum gregorii (Etheridge). Pl. VIII, figs. 1-4.

Campophyllum gregorii Etheridge, 1892. p. 60, pl. iii, figs. 15-18; 1895, p. 522, pl. xl, fig. 2. (Upper Middle) Devonian, Regan's Benwell's and Philp's Quarries, Reid Gap.

Non *Campophyllum gregorii* Chapman, 1912, p. 219, pl. xxxiv, figs. 3-5, which is "*Campophyllum*" *recessum* Hill, 1940c, p. 254, pl. ix, fig. 7.

Type Material: in the Collection of the Geological Survey of Queensland; the lectotype, here chosen, is F 1655, figured Etheridge 1892, pl. 3, fig. 15, from Regan's Quarry. Givetian.

Diagnosis: Disphyllum with ceratoid to cylindrical corallites with about 30 septa of each order; typically the major septa reach about half-way to the axis, while the minor septa are less than half as long; there is typically one or two series of small, very globose dissepiments, and the septa are dilated so that they extend laterally over the upper surfaces of the dissepiments; typically the tabulae are complete and horizontal, supplemented at the margins by smaller plates; variability is great; the number of series of dissepiments may increase, the septa may become long, and sometimes curved about a small axial space, when the tabulae become incomplete on concave floors; the dilation of the septa varies in amount and position.

Description: The corallum is phaceloid, the corallites arising by peripheral, parricidal increase, or by lateral non-parricidal increase. Ceratoid and cylindrical individuals occur, the cylindrical corallites being trochoid proximally. Cylindrical individuals are usually between 12 and 15 mm. in diameter. The corallites are all more or less rolled and worn, and are found in thin-bedded limestones consisting of transported skeletal matter. The compound coralla are usually broken up into dissociated fragments, so that hystero-corallites are rarely found connected to the parents, the break usually occurring at the junction of parent and hystero-corallite.

There are typically about 30 septa of each order; the major septa extend about half way to the axis, while the minor septa are less than half as long as the major; all the septa are dilated just inside the innermost dissepiments, so that their dilated tissue extends over the tops of these inner dissepiments; in the dissepimentarium itself the septa may be thin, or may dilate wedge-wise towards the periphery; the tabulae are complete, and fairly closely but irregularly spaced, with down-turned margins; or they are supplemented at the margins by small tabellae declined towards them from the dissepimentarium. There are two series of small, very globose dissepiments, but only the outer series is persistent. The trabeculae of the septa can be seen in vertical section to form a single series, about 5 in the space of 1 mm., directed upwards and inwards from the epitheca at about 45°.

There are many fragments from the Reid Gap, which, while of cylindrical form, differ from typical specimens in the position and amount of septal dilatation, and in having four or even five series of dissepiments. Usually the septal dilatation varies from one side of a corallite to another; thus the septa may be dilated wedge-wise towards the periphery from a point just inside the dissepimentarium, or this dilatation may cease at the inner edge of the dissepimentarium, so that the sections of septa within the dissepimentarium are thin; or these sections may again increase in thickness towards the periphery. In some corallites the zone of dilatation at the inner margin of the dissepimentarium may not be continuous from septum to septum, and may sometimes disappear altogether; in this case the septa may be thin throughout, or may thicken wedge-wise towards the periphery.

Other cylindrical fragments from the Reid Gap differ from typical forms in having longer major septa; these major septa may almost reach the axis, and they may be slightly curved in the tabularium; the length of the major septa causes the tabulae to be incomplete, and the supplementary tabellae become larger and more numerous, while the axial tabulae shorten and are usually concave; in vertical sections of such individuals there is a narrow axial area where the successive axial tabulae all are concave to approximately the same extent.

Localities: Burdekin Downs E; Fanning R. A, base and middle sections, F, ?G; Reid Gap A (type), B, C, ?E, F.

Remarks: The species is very variable in the Reid Gap. Frech's figure (1886, p. iii, fig. 3) suggests that *C. caespitosum* var. *breviseptata* Frech from the Refrath beds near Cologne is close to our species. Fliegel (1923) considered these beds to belong to the upper part of the German *Stringocephalus* beds. *D. gregorii* is also close to the European *D. goldfussi* from the Givetian and Frasnian, but differs from the figures of this species given by Lang and Smith (1935) in its septal dilatation and in its typically shorter major septa. Its septal dilatation is quite similar to that of *D. goldfussi* var. *hsianghsienense* Yoh (1937, pl. viii, fig. 1) from the *Stringocephalus* beds of North Kwangsi, but this Chinese form has major septa typically long, whereas in the great majority of Queensland specimens the septa are typically short. There is a close resemblance to species placed in *Cylindrophyllum* by American authors, particularly to *C. panicum* (Winchell)[1] from the top of the Traverse group of Michigan, in beds regarded as probably equivalent to some part of the Givetian of the European succession; but the dilatation of the septa over the inner series of dissepiments, so frequent in *D. gregorii* does not appear to occur in the American species. In *D. panicum* the trabeculae are often expanded laterally to form yard-arm carinae, but in *D. gregorii* the septa merely swell slightly at the trabeculae, in some individuals.

Disphyllum (or *Macgeea*).

Macgeea Webster; Lang and Smith, 1935, pp. 552, 577.

It is convenient to use this nomenclature for members of the Disphyllidae when one cannot ascertain whether they are solitary or fasciculate.

Disphyllum (or *Macgeea*) *trochoides* sp. nov. Pl. VIII, figs. 5-10.

Holotype: F 4557, University of Queensland Collection, Windmill on Fanning R. station, about 3 miles ESE of homestead. Givetian.

Diagnosis: Trochoid corallites with about 30 septa of each order, the major septa typically extending almost to the axis, and the minor septa being half this length; the septa may show ill-developed yard-arm carinae, and are typically rather thin; the dissepimentarium is wide, of small globose dissepiments; the tabulae are incomplete, with an inner series of flat or concave plates and an outer of declined tabellae.

Description: The corallites are trochoid; from the type locality there is no evidence that they were broken from fasciculate coralla, though they occur in thin beds of transported material; some from Burdekin Downs may have been fasciculate; thus two corallites may be joined laterally throughout their course, from apex to calice, or a small corallite may be laterally adherent to a large corallite; others from Burdekin Downs have a talon near the apex, suggesting that they were solitary. No associated difference in internal structure has been noted. The corallites may attain a diameter of 20 mm. in a height of 30 mm. Rejuvenescence occurs in many corallites.

There are 26 to 30 septa of each order. In the type locality the major septa usually reach almost to the axis, though occasionally they may be withdrawn almost to the dissepimentarium; the minor septa

[1] This species was wrongly referred by Hill, 1939a, p. 226, to the Couvinian.

extend nearly two-thirds of the way to the axis. The septa may become ragged, with irregular boundaries and internal spaces, and their trabeculae are frequently rather distant, and extended laterally into rather sporadically developed yard-arm carinae; there may be 6 of these in 3 mm., extending upwards and inwards in a gentle curve away from the epitheca. In the young stage the septa may be dilated to form a peripheral stereozone at the inner edge of the narrow dissepimentarium, as in *D. gregorii*, but in the adult such dilatation has disappeared. The dissepimentarium is wide, nearly two-thirds of the radius, and the dissepiments are small, globose, and often geniculate in transverse section of the corallum. The tabulae are in two series; in the holotype there is an inner series of rather large, distant, flat tabulae, and an outer series of tabellae inclined downwards from the dissepimentarium to the tabulae so that the arrangement is like that figured for *D. goldfussi* by Lang and Smith, 1935, p. 568); this arrangement is pronounced in those individuals with shorter major septa, but when the latter are long the large flat axial tabulae tend to be replaced by more numerous, smaller, arched tabellae.

Localities: Burdekin Downs A, B, D; Fanning R. ?A, C (type), F; Reid Gap A, B, E, ?F.

Remarks: The species shows considerable local variation. Thus in the specimens from Burdekin Downs the tabellae are frequently smaller and more numerous than in specimens from the type area; and in some, the septa are slightly curved in the tabularium, or considerably more dilated in the dissepimentarium. Some specimens from the base of the Fanning R. limestone, which are doubtfully included in the species, have a peripheral stereozone of some regularity. In specimens from the lower bed in portion 370 parish of Magenta, there is a striking resemblance to *D. goldfussi*, for the septa are only rarely ragged, and the major septa usually leave a moderately wide axial space.

D. (or *M.*) *spongiosum* (Schlüter; Wedekind, 1922, fig. 2) from the Büchel beds of Bergisch Gladbach in the Paffrath Basin appears to be very close to our species, but its yard-arm carinae are somewhat more distinct. *D.* (or *M.*) *conicum* (Kettnerova, 1932, p. 55) from the upper Givetian of Moravia, is comparable, but has irregularly yard-armed septa thickened fusiformly at the inner margin of the dissepimentarium, though not so much so as to be in contact. In many individuals the morphology of *D. trochoides* resembles that of the *D. goldfussi* group of the Givetian and Frasnian of Europe, but the dissepimentarium is constantly wider in our species, and the young stage of its holotype shows the septal dilatation characteristic of *D. gregorii*, with which indeed it may prove to be continuously variable.

Disphyllum (or *Macgeea*) *excavatum* sp. nov. Pl. VIII, figs. 11-13.

Holotype: D 42, Geological Survey of Queensland Collection, Burdekin Downs, on the N side of R., within three-quarters of a mile of the homestead. Givetian.

Diagnosis: The corallites are large, trocho-cylindrical and usually somewhat curved; they may attain a diameter of 35 mm. in a height of 30 mm., when rejuvenescence may occur. They appear to be solitary. The calice is deeply concave, and the epitheca, which may be discontinuous at the rejuvenescences, shows deep, narrow longitudinal grooves corresponding in position to the septa, with faint grooves midway between each.

There are from 28 to 34 septa of each order; the major septa extend half-way to the axis, or are a little longer; their axial ends may be rotated slightly; the minor septa are very short in the proximal parts of the corallum, but in the distal parts may be from one-third to one-half as long as the radius; the septa may be somewhat wavy; they are thin in the tabularium but are usually somewhat dilated in the dissepimentarium; in the proximal parts the dilatation is at the periphery, where they are dilated wedge-wise, and at the inner edge of the dissepimentarium, where the dilatation spreads over the dissepiments as in *D. gregorii*; or the septa may be but little dilated at the inner edge of the dissepimentarium, but may thicken gradually wedge-wise towards the periphery from this point. The tabularium is wide, and the tabular floors are deeply concave, with small inclined tabellae outside and concave tabulae inside. The dissepiments are small and globose but never horse-shoe shaped.

Localities: Burdekin Downs B (type); Fanning R. A. (base) ?; and at Mt. Success (L. C. B. Coll); Reid Gap E.

Remarks: The Reid Gap individuals suggest by their aggregation that they may be parts of a phaceloid corallum. Frech's figure (1886, pl. v, fig. 24) of *Cyathophyllum bathycalyx* Frech from the crinoid shales of Muhlberg near Gerolstein, suggests that this one of his syntypes is close to our species. These crinoid shales are presumably at the base of the lower part of the *Stringocephalus* beds of Germany.

FAMILY ENDOPHYLLIDAE.

Endophyllidae; Torley, 1933, p. 633.

Typical Genus, *Endophyllum* Edwards and Haime.

Sub-fasciculate, cerioid or plocoid Rugosa with a lonsdaleoid dissepimentarium and domed tabulae with upturned edges, the major septa being vortically arranged about a small axial space.

Endophyllum and *Sanidophyllum* Etheridge (1899, p. 154) which occur together in the Givetian of New South Wales, appear to be closely related. *Sanidophyllum* differs from *Endophyllum* in having the tabularia naked of dissepiments for the most part, but united at intervals throughout the corallum by dissepimental platforms, which are very thin and form cerioid calical floors, over which the septa are dilated and laterally contiguous.

Genus *Endophyllum* Edwards and Haime.

Endophyllum Edwards and Haime; Jones, 1929, p. 84.

Genolectotype: Endophyllum bowerbanki Edwards and Haime; chosen Schlüter, 1889, p. 51.

Diagnosis: Sub-phaceloid, cerioid or plocoid Rugose corals in which the septa are discontinuous and dilated within the dissepimentarium, where they are developed as septal crests on the dissepiments. The tabulae are incomplete, and the tabular floors are domes with upturned margins. The dissepiments are large and lonsdaleoid. The major septa are arranged in a vortical axial structure, hollow at the axis.

Remarks: The genotype is an aphroid species, there being no wall between the corallites, which are in contact by means of dissepimental tissue. Its neotype is from the Upper Devonian of Rocky Valley, Torquay, but the type was from the Givetian or Frasnian of Barton, near

Torquay. Its distribution is not known, as it is not mentioned in the Survey Memoirs on Torquay and Newton Abbott. Schlüter (1889, p. 52, pl. vi, figs. 1-3) identified with it his *Darwinia perampla* from the German *Stringocephalus* beds, and Torley (1933) has considered *Ptychophyllum palmatum* Maurer from the Waldgirm limestone to be identical with it.

A cerioid species, *E. abditum* Edwards and Haime was collected from a beach pebble at Teignmouth, and is from an unknown horizon in the English Devonian. The cerioid *E. yunnanense* Mansuy (1912, p. 48) is from the Middle Devonian (Eifelian) of Yun-nan, S. China.

In the New South Wales Givetian, *Endophyllum* is represented by both cerioid and aphroid forms; the aphroid form is *E. schlüteri* Etheridge (1898, p. 43, pls. iv, v) and is possibly conspecific with *E. bowerbanki*; and the cerioid form is *E. schlüteri* var. *colligatum* Etheridge (1920, p. 55, pl. xiii), which is extremely close to if not conspecific with *E. abditum*. The specimens described below from the Fanning R. belong to this cerioid group.

Endophyllum abditum var. *columna* nov. Pl. VIII, fig. 14; pl. IX, fig. 1.

Holotype: F 4275 University of Queensland Collection, top of limestone, Fanning R., 1½ miles upsteam from homestead. Givetian.

Diagnosis: Cerioid *Endophyllum* with septa typically not extending outside the tabularium, which appears as a fairly regular column.

Description: The corallum is cerioid, the average diameter of the corallites of any one corallum varying from 12 to 22 mm., and in the one corallum the corallites are unequal. There are 23 septa of each order, thin throughout and confined to the tabularium; the major extend towards the axis, showing a slight but somewhat irregular vortical curvature, and leaving a rather irregular axial space. The minor septa are seen as short ridges on the wall of the tabularium, a wall formed by the innermost series of dissepiments. Rarely the septa may be continued as crests on the outer dissepiments and common outer wall of the corallites. The dissepiments are very large, and rather steeply inclined. The tabularium is on the average 7 mm. wide; the tabulae are flattened domes with upturned margins, reinforced occasionally with smaller plates at the margins or on the domes.

Remarks: This species belongs to the group of *E. abditum*. It differs from *E. abditum* figured by Jones (1929, pl. x., figs. 3, 4) in having its septa confined to the tabularium, which is relatively narrow, in the smaller number of septa, and in the absence of trabecular differentiation of the septa; also, its septa are thin. It differs from the N.S.W. species *E. colligatum* in the same ways.

FAMILY FAVISTELLIDAE (OR COLUMNARIIDAE).

Favistellidae (or Columnariidae); Hill, 1939b, p. 241; 1940a, p. 155; 1940c, p. 262.

Genus *Favistella* Hall.

For a discussion of the taxonomy of *Favistella* and *Columnaria* see Lang and Smith 1935a, and Hill, 1939b, p. 240; 1940a, p. 155. Weissermel (1897, p. 873) has reviewed species which he considered generically related to *Columnaria alveolata* Hall. He distinguished two groups, one with walls as in *C. alveolata* (i.e. *F. stellata*, the genotype of *Favistella*), and the other with thick walls, including

Cyathophylloides rhenanum Frech. This thick-walled group, which consisted of two solitary, two phaceloid and one cerioid species, he placed in the subgenus *Pycnophyllum* Dybowski, this name being an invalid correction for *Densiphyllum* Dybowski. He has recently (1938, p. 68) added a second cerioid species. Lang, Smith and Thomas (1940, p. 49) have shown that *D. thomsoni* Dybowski is genolectotype for *Densiphyllum*. But this is a solitary species and I doubt that it is congeneric with the compound forms. Dybowski's figures suggest that it is a Streptelasmid. Until material can be assembled for a critical revision of all these thick-walled forms, the most reasonable course appears to be to consider the compound species under the genus *Favistella*.

Favistella rhenana (Frech). Pl. IX., figs. 2, 3.

Cyathophylloides rhenanum Frech, 1886, p. 207, pl. xv., figs. 19, 19a; upper *Stringocephalus* limestone (beds with *Uncites gryphus*) near Hand in the Paffrath Basin, and at the same horizon at Brilon.

Type Material: Possibly at Breslau.

Diagnosis: Thick-walled phaceloid *Favistella*; two opposite septa of the 18 major septa are longer than the others.

Description: The corallum is phaceloid, the corallites being long and straight, and usually from 6 to about 10 mm. in diameter, with a smooth epitheca. Increase is peripheral and may be parricidal. The wall is on the average 1 mm. thick. There are from 16 to 20 major septa, usually 18, of which two opposite ones are frequently longer than the others and thus divide the corallite into two halves; the others are unequal and may be somewhat curved. The alternating minor septa project but little beyond the wall. The septa are moderately thick in the tabularium, but expand greatly at the periphery so that they are closely in contact and thus form the thick wall. The tabulae are thin, rather distant and complete, usually slightly domed, and sometimes with an axial depression. There are no dissepiments.

Localities: Burdekin Downs B; Fanning R. A (beds e-g), B, G; Reid Gap D.

Remarks: I can find no difference between a specimen kindly sent by Prof. W. Weissermel from Schwelm in Westphalia, and those from North Queensland. In the Paffrath Basin, in addition to the type horizon, it occurs (Fliegel, 1923, p. 370) in the *quadrigeminus* (upper Honsel) beds. Sochkina has described two very similar species from the Urals, one, *F. vulgaris* (Sochkina, 1936, p. 22) from the Givetian and the top of the Silurian (Sochkina, 1937, pl. ii., figs. 4, 5) and the other *F. quadriseptata* (Sochkina, 1937, pl. ii., figs. 2, 3) from the top of the Silurian. Possibly *Thamnophyllum murchisoni* of Le Maitre (1937, pl. vii., fig. 12) from the Givetian of Ville-Dé-d'Ardin is a *Favistella* near *rhenana*.

Genus *Fasciphyllum* Schlüter.

Fasciphyllum Schlüter; Lang and Smith 1935, p. 548; Hill, 1939a, p. 241; 1940a, p. 155.

Fasciphyllum ryani sp. nov. Pl. IX, figs. 4, 5.

Holotype: F 5018, University of Queensland Collection, anabranch of Burdekin R., near Big Rocks, Burdekin Downs station. Givetian.

Diagnosis: *Fasciphyllum* with corallites about 6 mm. in diameter, and with dissepiments whose curvature in vertical section approximates a right angle.

Description: The corallum is phaceloid, and increase is peripheral and non-parricidal; the corallites are unequal, from 3 to 9 mm. in diameter, the average being 6 mm. They may be in contact or up to 4 mm. apart. There is a narrow peripheral stereozone about 0·5 mm. wide. There are 14 to 17 slightly unequal major septa which extend to or almost to the axis, and which are somewhat wavy in the tabularium. The alternating minor septa are from half to two-thirds as long as the major septa. The septa are thin except where they expand at the periphery to form the stereozone. The dissepiments are in single series, but this may be reinforced either at the periphery or near the tabularium by much smaller plates; in vertical section they give a curve which closely approximates a right angle; that is, near the periphery it is almost horizontal, but at the tabularium it suddenly curves downwards so that it is almost vertical. The dissepiments do not interrupt the septa except where increase is about to occur. The tabulae are complete, concave and rather distant, except in the proximal parts of young corallites, where they are slightly domed, and extend from stereozone to stereozone without the intervention of any dissepiments.

Localities: Burdekin Downs E (type); Reid Gap E, and Calcium.

Remarks: The inclination of the dissepiments distinguishes this species from others of the genus.

FAMILY SPONGOPHYLLIDAE.

Spongophyllidae; Hill, 1939b, p. 58; 1940c, p. 267.

Genus *Spongophyllum* Edwards and Haime.

Spongophyllum Edwards and Haime; Hill, 1939, p. 60.

Three of the cerioid Middle Devonian species previously placed in the genus (Hill, 1939b, p. 60) appear to form a morphological sub-group to which our species described below may be added, although it is phaceloid. They are *Spongophyllum kunthi*, *S. parvistella* and *S. ligeriense*. All have a peripheral stereozone, and in all, when lonsdaleoid dissepiments occur, the stereozone is frequently developed on their upper surfaces. The first two are lower Givetian and the third transitional from Coblenzian to Couvinian. Our new species is more like the Lower Givetian forms than the earlier one, which sometimes has one of its septa longer than the others and slightly dilated at the axial end. In *S. parvistella* a morphology like that of the Favistellidae is seen in the proximal parts of the oldest corallites of a colony.

Spongophyllum immersum sp. nov. Pl. IX, figs. 6a, b.

Holotype: Z 82 in the Geological Survey of Queensland Collection from Arthur's Ck., Burdekin Downs. Givetian.

Diagnosis: Phaceloid *Spongophyllum* with a peripheral stereozone with minor septa infrequently suppressed, and with lonsdaleoid dissepiments irregularly developed, and frequently with a narrow stereozone on their upper surfaces; there are several series of dissepiments inside the zone of lonsdaleoid dissepiments.

Description: The holotype, the only specimen collected, is a phaceloid corallum immersed in a stromatoporoid. Most of the corallites are from 4 to 6 mm. in diameter, but some are smaller and a few are larger;

they are at least 40 mm. long (the length of the specimen) and straight; the distance between them varies between nil and 6 to 10 mm. The manner in which the new corallites arise was not observed.

Most corallites have a peripheral stereozone about 0·05 mm. wide, but in some it is narrower. There are 14 or 15 major septa, extending unequally to the axis, and somewhat wavy in the tabularium. The minor septa are about half as long as the major septa, and are occasionally suppressed, or at least become discontinuous between dissepiments. Individual trabeculae are not distinguishable in the septa, which are thin except where they expand into the stereozone at the periphery or on the upper surfaces of lonsdaleoid dissepiments. These lonsdaleoid dissepiments are frequently but irregularly developed, and may form a peripheral zone 2 mm. wide. They are large and globose, but smaller, highly inclined dissepiments are developed in the interseptal spaces between them and the tabularium. The tabulae are typically complete, close and concave, and sometimes with a median deepening, when they may be reinforced by an outer series of tabellae.

Remarks: This species is closely similar in internal structure to *S. kunthi* and *S. parvistella* from the lower part of the German *Stringocephalus* beds, but these are cerioid, whereas the Queensland species is phaceloid.

Genus *Grypophyllum* Wedekind.

Grypophyllum Wedekind, 1922, p. 13; 1925, p. 16; *partim*; Hill, 1940c, p. 267.

Grypophyllum sp. Pl. IX, figs. 7a, b.

Figured specimen, F 4501, University of Queensland Collection, base of Fanning R. limestone, Fanning R. about 2 miles above Fanning R. homestead. Givetian.

Description: The only specimen is of cylindrical corallites from 8 to 12 mm. in diameter, aggregated as if in a compound corallum. There is a narrow peripheral stereozone 1 mm. wide formed by the sudden expansion of the peripheral ends of the septa. There are 23 septa of each order, all rather thin except in the peripheral stereozone; the major septa extend to the axis, where those from two opposite sides of the corallite interdigitate; the minor septa are half as long as the major, when fully developed, but some of them are withdrawn to the periphery, leaving large inosculating dissepiments; in other loculi the dissepiments are normally curved or geniculate. In vertical section the dissepiments are in two zones, an outer of more steeply inclined plates than an inner. The tabular floors are flat lying, and are formed of small, close, flat-lying tabellae.

Remarks: The internal structure of this coral is almost identical with that of *Grypophyllum normale* Wedekind (1925, fig. 25) from the *quadrigeminus* beds of Hand, in the Paffrath Basin, near Cologne.

Grypophyllum compactum sp. nov. Pl. X, figs. 1-4.

Holotype: F 5317, University of Queensland Collection, portion 81v, parish of Wyoming, lower part of limestone, Reid Gap. Givetian.

Diagnosis: The corallum is phaceloid, the corallites being unequal, 5 to 20 mm. in diameter, arising by lateral increase. Calice and epitheca have not been seen. In corallites of average size (about 14 mm.), there are 23 perfectly developed thin minor septa alternating with 23 long

major septa; in larger corallites there may be 29 each; the septa are dilated at their bases to form a narrow peripheral stereozone about 1 mm. wide, but inside this they are moderately thin, becoming thinner towards the axis. The major septa extend somewhat unequally to the axis, where those from opposite sides may interdigitate; the minor septa may be a little more than half as long as the major. The septa in the largest corallite are slightly carinate, with xyloid carinae. The dissepiments are small and somewhat globose, and those of the outer series are more steeply inclined than those in the inner series. The tabularium is narrow, and the tabular floors are almost flat, being either slightly arched or saucered, and are formed by small, closely spaced, flat-lying tabellae.

Remarks: The septa of this species are very like those figured for *Grypophyllum tenue* Wedekind (1925, fig. 27) from the *quadrigeminus* beds of Hand in the Paffrath Basin, and further examination of material of both species may prove them identical.

Genus *Stringophyllum* Wedekind.

Stringophyllum Wedekind, 1922, p. 8; 1925, p. 64.

Neospongophyllum Wedekind, 1922, p. 10; 1925, p. 25; genotype, *Neospongophyllum variabile* Wedekind, 1922, p. 12, text-fig. 11; 1925, text-fig. 90, *quadrigeminus* beds of Hand, Paffrath Basin.

Loepophyllum Wedekind, 1925, p. 55 (as *Loipophyllum*) genotype, *L. kerpense* Wedekind, id., text-figs. 80, 81. Kerp (? middle coralline limestone), Middle Devonian, Eifel.

Schizophyllum Wedekind, 1925, p. 59, genotype *Spongophyllum büchelense* Schlüter, Büchel beds, Büchel, Paffrath Basin. *Schizophyllum* was pre-occupied in 1895 for a myriapod.

Grypophyllum Wedekind, 1922, p. 13, and 1925, p. 14, *partim,* i.e. *Cyathophyllum isactis* Frech and *G. schwelmense* Wedekind, from the upper part of the *Stringocephalus* beds of Germany.

Genotype: Stringophyllum normale Wedekind, 1922, p. 9; *Stringocephalus* limestone of Sundwig; and (*quadrigeminus* beds of) Hand, Paffrath Basin, Rhenish Prussia.

Diagnosis: Rugose corals in which the rather thick septa are arranged bisymmetrically about an elongate axial pit in the plane of the cardinal and counter septa; each septum consists of a single series of discrete or laterally contiguous monacanths from about 0·3 to 0·6 mm. in diameter, and the tabulae are concave, each with an elongate axial pit; the septa may withdraw from the periphery, or become discontinuous in the peripheral region, when lonsdaleoid dissepiments may develop; the minor septa are typically more discontinuous than the major septa.

Range: The genus is characteristic throughout the *Stringocephalus* beds of Germany: it also occurs in the lower Givetian of Kwangsi, China (Yoh, 1937) and in the upper Givetian of Moravia (Kettnerova, 1932). It extends as low as the Chaudefonds limestone of France, which Le Maitre (1934) regards as transitional between Coblenzian and Couvinian. I have not recognised it from Africa or the Americas, but it is characteristic of the Givetian of Queensland.

Remarks: There is in the north Queensland *Stringocephalus* beds a number of forms in which moderately thick septa are arranged bisymmetrically about an axial depression. Each septum consists of a single series of monacanths about 0·3 or 0·6 mm. in diameter. In all forms the axial depression is elongated in the plane of the counter and cardinal septa and deepens the already concave tabulae, which are usually complete. Certain variations are characteristic of the group. The most striking is that the monacanths in a septum tend to become separated; the second is that the septa tend to withdraw from the periphery; the third is that this withdrawal affects the minor septa more than the major septa, and in the limiting cases the minor septa are completely suppressed. With the withdrawal of the major septa is associated the development of lonsdaleoid dissepiments at the periphery. There is also some variation in the thickness of the septa, and occasionally a tendency for the withdrawal of the septa from the axis. All of the north Queensland specimens of the sub-groups which I take to be species, within this group, possess all these types of variability, the differences being merely in degree, and it seems to me to be best to recognise the whole group as a genus. It will be seen that with the exception of the pronounced bisymmetry of the tabularium, and the septal structure of large monacanths, these characters are those diagnostic of *Spongophyllum;* and our forms are therefore regarded as members of the family Spongophyllidae.

The same group occurs in Germany, and has there been split up into a number of genera by Wedekind. What I regard as a genus in Australia, he regards as a family (Stringophyllinae) in Germany, and the merits of the two systems must be tested by their practicability. Wedekind's genera may be analysed in terms of the types of variability outlined above, as follows.

Stringophyllum; withdrawal of septa affects only minor septa, consequently the appearance of lonsdaleoid dissepiments is rare; separation of monacanths is but little operative.

In his *Schizophyllum* (this name is pre-occupied) the dominant variation is that of the separation of the monacanths, but withdrawal of the septa from the periphery is also effective, the minor septa being affected but little more than the major, and lonsdaleoid dissepiments are fairly common.

In his *Neospongophyllum* the dominant variable is the withdrawal of the septa and the occurrence of lonsdaleoid dissepiments; typically there are still traces of minor septa.

His *Loepophyllum* differs from his *Neospongophyllum* in the typically complete suppression of the minor septa. (Possibly Schlüter's *Spongophyllum torosum* and *S. elongatum* are of this morphology, also *S. rosiforme* Yoh, 1937, pl. vi., fig. 1 from the lower Givetian of Kwangsi, S. China). In both these genera there is a slight tendency to separation of the monacanths.

His Grypophylla with thickened septa, which however he placed in a different family from the Stringophyllinae, show complete major septa, and typically, therefore, no lonsdaleoid dissepiments; those without minor septa he placed in *Grypophyllum isactis* (Frech), and those with traces of minor septa in the inner part of the dissepimentarium he referred to *G. schwelmense*.

It will be seen that his system of generic names does not cover all the mathematical combinations of these lines of variability, but perhaps not all such variations occur in Germany. I have been unable so far to examine individuals from Germany in the large numbers necessary for an independent evaluation of species limits and the variation within species in that country. Wedekind has suggested lines of evolution within the group, but his papers give no discussion on the limits of variability within species, and consequently his lines of evolution cannot be independently evaluated. Examination of collections from other localities and horizons in Germany than those studied by Wedekind is also required.

It should be noted that in this genus the appearance of the tabulae in vertical section will vary according to the orientation of the section. Thus if they be cut at right angles to the cardinal-counter axial depression, the tabulae will show this depression centrally; if this type of section be taken through both alar fossulae, these alar depressions will widen the central one; if the tabulae are cut parallel to the axial depression, they will appear either horizontal, or with but a shallow axial depression, or in some cases, will even appear to be domed.

Stringophyllum quasinormale sp. nov. Pl. X, figs. 5-9.

Holotype: F 4528, University of Queensland Collection, base of Fanning R. limestone, 2 miles upstream from Fanning R. homestead. Givetian.

Diagnosis: Cylindrical *Stringophyllum* with about 38 major septa typically continuous, and minor septa more or less continuous, being frequently represented by long septal crests; with monacanths only infrequently separate, and with almost horizontal, complete, axially depressed tabulae.

Description: The corallum is cylindrical and fairly straight, usually about 15 mm. in diameter, but sometimes a little more or less. All specimens are fragments, and it may be that the corallum is phaceloid, although there is no direct evidence of this. Some slight growth constrictions and expansions are characteristic, but the epitheca is continuous across them. The epitheca shows faint growth annulation and longitudinal striation. The fragments from the different localities show slightly different characters and will be described below in groups.

Type locality: The holotype is the only specimen from the type locality. It is about 20 mm. in diameter, and has 42 major septa and an equal number of minor septa; both orders are moderately thickened; the major septa are arranged more or less bisymmetrically about the cardinal-counter plane, and most of them reach the axial plane. Those near the cardinal and counter and two alar fossulae have their axial ends curved towards these fossulae, but the remainder are directed towards the appropriate points along a narrow space elongated in the cardinal-counter plane. The counter septum is longer than the cardinal, and its two neighbouring minor septa are longer than the other minor septa, which are from half to two-thirds as long as the major septa. The major septa are continuous from periphery to axis, but the minor septa which are thinner than the major, are discontinuous here and there and are represented by segments based on dissepiments. Where the minor septa are discontinuous the dissepiments cross the loculi from one major septum to its neighbour. No monacanths are distinguishable in the transverse section figured in plate X, fig. 5a, but they can be traced in the vertical section, fig. 5b. They are contiguous, and are about 0·5 mm.

in diameter, directed upwards and inwards from the periphery at an angle of about 45°. The dissepiments are arranged in about ten series, and are rather large, the inner ones being more steeply inclined and longer than the outer. The tabulae are complete, moderately distant, and slightly concave, with an axial depression which is elongated along the counter-cardinal plane.

Limestone dam, Burdekin Downs. At this locality, whence we have the most specimens of the species (about 30), where the fragments are of a slightly smaller diameter, and the usual number of septa is 38 of each order, we find considerable variation; in some individuals the minor septa are as infrequently discontinuous as in the holotype; in others there are many discontinuous, when the dissepiments stretch right across the loculi between one major septum and the next, and the minor septa are represented as long crests on the dissepiments; in others again some of the major septa have withdrawn a little from the periphery, and a few lonsdaleoid dissepiments are consequently found. In general the thickness of the septa is a little greater than in the holotype. Usually monacanths are indistinguishable in the transverse section, though clearly visible in the vertical section, where they are seen to be usually of a diameter of 0·5 mm., and to make an angle of 45° to the epitheca; occasionally separate monacanths can be seen in transverse section however. The dissepiments and tabulae are as in the holotype.

Anabranch of the Burdekin R., near Big Rocks, Burdekin Downs. One specimen differs from the holotype only in having slightly thicker septa, in which the monacanths are occasionally discernible in transverse section, whether contiguous or separate. The septa are also in part slightly withdrawn from the axis. A number of specimens with slightly different characters which occur at this locality are described below as a variety, *ana*.

Portion 370, parish of Magenta, Reid Gap. Two specimens (F 5251 and F 5294) differ from the holotype only in the greater thickness of the septa; the first shows slight withdrawal of some septa from the axis. Two other specimens (F 5247 and F 5299) show almost complete withdrawal of the minor septa, occasional separate monacanths, and a withdrawal of the septa from the axis, where there are ends of several separate monacanths.

Portion 54, parish of Wyoming, Reid Gap, F 5259, the only specimen, differs from the holotype only in that the minor septa are completely withdrawn and there are several separate monacanths visible in the transverse section.

Localities: Burdekin Downs E, F; Fanning R. A (type); Reid Gap E, F.

Remarks: Within the individuals comprised in the species, from the various localities, the limits of variability in those four directions proper to the genus are:—withdrawal of the minor septa is typically very slight, but it may be complete; withdrawal of the major septa is typically very slight, so that only occasional lonsdaleoid dissepiments are developed; separation of the monacanths is unimportant, but may occur; there may be slight withdrawal of the septa from the axis. The number of septa of each order is typical, usually 38, but not less than 33 and not more than 42; the cylindrical, fairly straight form is typical also.

This north Queensland species has amongst its individuals some which are practically identical in transverse section with Wedekind's figured specimen of *S. normale,* from the *Stringocephalus* limestone of Sundwig, Germany, but our specimens do not show any vertical inner dissepiments (which Wedekind has described as an outer series of tabulae), such as are figured for the genotype. And as we do not know the limits of variation in the genotype, which is larger (nearly 30 mm. in diameter), I do not feel that specific identity is established between the north Queensland species and the German.

Stringophyllum quasinormale ? var. Pl. X, figs. 10a, b.

Holotype: F 5087, University of Queensland Collection, limestone dam on Burdekin Downs station. Givetian.

Diagnosis: Large *Stringophyllum quasinormale,* with more numerous septa (up to 47 of each order) and some lonsdaleoid dissepiments.

Description: The corallum is thick and somewhat vermiform. The holotype is 30 mm. and the other two specimens from the type locality are 20 mm. in diameter. The holotype has 47 major septa, and the other two 44 and 40. In the holotype the minor septa are occasionally withdrawn and discontinuous, long crests being based on the dissepiments. In some places also the major septa are discontinuous and lonsdaleoid dissepiments are formed. In the two smaller specimens the minor septa are much less continuous. Some separate monacanths can be found. The major septa are long and reach right to the axis, the arrangement of their axial ends being as in *S. quasinormale,* and not at all withdrawn from the axis; in the holotype they tend to be somewhat sweepingly curved. The dissepiments are as in *S. quasinormale,* but the tabulae, in the only vertical section cut, are V-shaped and complete.

Remarks: These three specimens, while much larger than those typical of *S. quasinormale,* and having more septa, yet have a morphology closely comparable to that species, and at most are probably only to be regarded as a variety thereof. These large specimens are known only from one locality, where they occur with numerous specimens of the species itself. As so few specimens are known, they are not given a varietal name. They probably indicate the age of the *quadrigeminus* beds of Hand or the *Stringocephalus* limestone of Sundwig in Germany.

Stringophyllum quasinormale var. *ana* nov. Pl. X, figs. 11-14.

Holotype: F 5011, University of Queensland Collection. Anabranch of the Burdekin R., near Big Rocks, Burdekin Downs Station. Givetian.

Diagnosis: Small *S. quasinormale* in which there are fewer septa (32 to 38 of each order), and in which the minor septa are frequently entirely withdrawn.

Description: About 30 cylindrical and somewhat vermiform fragments suggest that the corallum may have been phaceloid, although no offsets were found. Most are somewhat weathered, though a few show the epithecal characters of *S. quasinormale.* In diameter they vary from 10 to 15 mm. In about half of the specimens, the minor septa are represented by crests on the dissepiments; in most coralla these occur somewhat sporadically, but in some they form a fringe round the inner

part of the dissepimentarium. In the other half of the specimens, traces of minor septa are either absent or rare. The specimens with the smaller diameters are usually those without minor septa, but not always. The septa are typically thinner than in *S. quasinormale* itself, and are finely wavy. The dissepiments and tabulae are similar to those in *S. quasinormale*. Separation of the monacanths is only occasionally observed. Many of the specimens have been crushed so that the septa near one diameter have been smashed together.

Remarks: The smaller average size and the frequency with which the minor septa are completely withdrawn distinguish some thirty specimens from the anabranch of the Burdekin R. near Big Rocks as a variety of *S. quasinormale*. One or two specimens from the locality however are of *S. quasinormale* itself.

Stringophyllum bipartitum sp. nov. Pl. XI, figs. 1-3.

Holotype: F 4398, University of Queensland Collection, beds a-g limestone in Fanning R. 1½-2 miles above Fanning R. house; Givetian.

Diagnosis: Very large *Stringophyllum* with 50-58 major septa, extending irregularly nearly to the elongate axis, and typically withdrawn in part from the periphery so that irregular lonsdaleoid dissepiments occur; minor septa are occasionally present, as septal crests; the monacanths are sometimes separate.

Description: The corallum is large, diameters up to 40 mm.. being found, though 30-35 mm. is the average. No offsets have been seen, but from the association of individuals in the matrix it is thought that the species might be compound. One fragment is 15 cm. long. Growth constriction and swellings are frequent. There are from 50 to 58 major septa, which extend irregularly to the elongate axis characteristic of the genus; they are moderately thick and are irregularly withdrawn from the periphery so that lonsdaleoid dissepiments occur frequently. They may be represented by separate monacanths in their peripheral parts, or near the axis. The counter septum is frequently longer than all the others. Minor septa are only occasionally developed, as crests on the dissepiments, or as a series of separate monacanths. The dissepiments and tabulae are as is characteristic for the genus; the dissepiments are more globose and less steeply inclined in the outer series than in the inner. The tabulae are typically complete, and are concave with an axial deepening in the plane of the cardinal and counter septa.

Localities: Fanning R. A (a-g type), B, E; Reid Gap D.

Remarks: The species somewhat resembles *S. büchelense* (Schlüter) of Wedekind (1925), from the upper Honsel beds of Genna, Germany; but this Genna specimen shows a better development of minor septa and a greater tendency to separation of the monacanths.

Two specimens F 4394 and F 4400, occurring with this species at its type locality have a greater diameter (50 mm.) and more septa (66 to 70). They show a wider axial space than is typical, and a fair development of crests on the minor septa. They may represent a variety, but we have too little material to judge.

Stringophyllum irregulare sp. nov. Pl. XI, figs. 4-8.

Holotype: F 4904, University of Queensland Collection, Burdekin Downs station (fence running north from the east end of the night paddock). Givetian.

Diagnosis: Stringophyllum with about 40 major septa, usually somewhat withdrawn from the periphery, with irregular development of lonsdaleoid dissepiments; minor septa are typically absent and major septa frequently withdrawn from the axis; separation of the monacanths is occasionally observed.

Description: The corallites are all cylindrical fragments without offsets, so that we do not know if the corallum be solitary or compound. Some talon-like processes are seen on some specimens, and some fragments are of small diameter (13 mm.) compared with the average (20 mm.), although they have the same number of septa (40), suggesting that the species is compound. Most fragments are rather worn externally, but some show the epitheca with faint growth annulation and longitudinal striation, and small irregular growth swellings and constrictions. There are on the average 40 moderately thick major septa, which may extend from the epitheca to the elongate axis characteristic of the genus, but usually they are irregularly withdrawn from the periphery, so that lonsdaleoid dissepiments are developed. The septa may occasionally be rather irregularly curved in the tabularium, but typically they have the arrangement characteristic of the genus, although frequently they are somewhat withdrawn from the axis also. Their monacanths may occasionally be separate. The dissepiments and tabulae are those characteristic of the genus; in some individuals the dissepiments are more globose and less steeply inclined than in others.

Localities: Burdekin Downs D (type), F; Fanning R. A. (beds h-j), F, ?G; Reid Gap E, G.

Remarks: In its internal structure this species is perhaps most closely similar to *S. tenue* (Wedekind, 1925, figs. 74, 75) from the old calamine mine red earth near Schwelm, i.e. probably in the upper part of the German *Stringocephalus* beds, although his figures show more frequent separation of the monacanths than in our form. There is the same size of corallum and number of septa. There is also a close morphological resemblance to the specimens from the lower part of the German *Stringocephalus* beds of Kerp and Baarley, placed by Wedekind (1925, pl. 14) in *Loepophyllum*. Our species is also comparable with *S. torosum* (Schlüter) from the lower part of the *Stringocephalus* beds at Berndorf, as figured by Schlüter (1881, pl. vi, figs. 1-5), although this has fewer septa (35) and a narrower dissepimentarium. It does not appear to resemble at all closely the specimens figured as *Spongophyllum torosum* Schlüter by Le Maitre (1934, pl. vi, figs. 3-6) from the Chaudefonds limestone transitional between Coblenzian and Couvinian.

One specimen from the type locality for *S. irregulare*, and two from the limestone dam on Burdekin Downs, are similar to the species except that there are more major septa, 44 to 46, and these are only seldom withdrawn from the epitheca, and then very slightly. As they are so few, they are doubtfully referred to *S. irregulare*.

Stringophyllum isactis (Frech). Pl. XI, figs. 9-11.

Cyathophyllum isactis Frech, 1886, p. 75 (189), pl. i, fig. 7, pl. ii, figs. 13-18, *non* fig. 19; upper *Stringocephalus* beds of Schladetal in the Paffrath Basin, and Soetenich in the Eifel.

Grypophyllum isactis (Frech), Wedekind, 1922, p. 15, Büchel beds near Hand, Paffrath Basin; Wedekind, 1925, p. 17, figs. 12-14, Massenkalk of Schladetal; and Soetenich.

Type material is probably at Berlin or Breslau.

Diagnosis: Phaceloid *Stringophyllum* with corallites about 10 mm. in diameter; there are 28 slightly thickened major septa, minor septa being typically completely withdrawn; the major septa sometimes withdraw so that lonsdaleoid dissepiments form; separation of the monacanths occasionally occurs.

Description: The corallum is phaceloid, increase being by one or sometimes two offsets arising in the outer dissepimentarium and growing laterally without killing the parent. The corallites are from 8 to 12 mm. in diameter, have slight changes in direction of growth and show slight irregular growth swellings. The outer tissue may project in talon-like processes, anchoring one corallite to its neighbour. The epitheca shows only very faint growth annulation and longitudinal striation. There are 28 or 30 major septa, which are usually moderately thick; they nearly reach an elongate axis, being slightly withdrawn so that there is an oval axial space in many transverse sections, in which however, sections of separate monacanths may be seen. Occasionally the major septa may withdraw from the periphery, so that lonsdaleoid dissepiments develop, particularly where offsets or anchoring processes arise. Usually individual but contiguous monacanths may be distinguished in the septa, although occasionally they may be separate. They are about 0·6 mm. in diameter. Only very occasionally traces of minor septa occur. The dissepiments are large and globose, particularly in the connecting processes, usually in one to three series, the inclination of the innermost becoming almost vertical. The tabulae are typically concave, complete, with an axial deepening in the cardinal-counter plane; small plates may develop across this depression.

Remarks: Many of the specimens from the top of the Fanning R. limestone are identical in internal structure with *S. isactis* (Frech) as figured by Wedekind (1925, p. 19, fig. 12) from Schladetal (Massenkalk, upper part of the German *Stringocephalus* beds). The species also occurs in the upper Givetian of Moravia (Kettnerova, 1932, figs. 30-32). *Cyathophyllum* cf. *isactis* Frech has been recorded from the Givetian and Upper Devonian of Russia by Lebedew (1902, p. 150), but his figures (pl. iii, figs. 43-44) show a morphology rather different from the German species.

F 4962 from Burdekin Downs homestead, on the hill rising from the fowlyard, may belong to the species; it has 29 major septa, and some lonsdaleoid dissepiments, but it is somewhat larger in diameter than the corallites from the Fanning R., with a wider dissepimentarium of smaller dissepiments. It is only a fragment, and it is not known whether it is from a phaceloid corallum or is a solitary individual.

ACKNOWLEDGMENTS.

This work has been carried out while the author held a Research Fellowship within the University of Queensland, financed by Commonwealth funds through the Council for Scientific and Industrial Research. Grateful acknowledgment is made of the loan of specimens in the Geological Survey of Queensland Collection, by Mr. L. C. Ball, B.E., Chief Government Geologist, and of the gift by Prof. W. Weissermel of comparative material from Germany. For the photographs illustrating the paper I am indebted to Mr. E. V. Robinson of the Department of Geology of the University of Queensland.

My collecting party received the kindest of hospitality from Mr. and Mrs. W. Salmon, of Burdekin Downs, Mr. and Mrs. Harry Clarke, of Fanning R., and Mr. and Mrs. Martin Ryan, of Reid Gap.

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EXPLANATION OF PLATES.

PLATE V.

Except where otherwise noted, the specimens are all in the University of Queensland Collection.

All figures × 1·8 diameters.

Acanthophyllum sweeti (Etheridge).

Fig. 1. F 1652. Lectotype. Geological Survey of Queensland Collection. Regan's, Reid Gap. Givetian. *a*, transverse, and *b*, vertical section.

Fig. 2. F 4963. Burdekin Downs, hill behind fowlyard. Givetian. *a*, transverse, and *b*, vertical section.

Fig. 3. F 4966. Burdekin Downs, hill behind fowlyard. Givetian. Transverse section.

Fig. 4. F 5015. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Fig. 5. F 5012. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Dohmophyllum clarkei sp. nov.

Fig. 6. F 4531. Holotype. Base of Fanning R. limestone, Fanning R. about 2 miles upstream from Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 7. F 4451. Base of Fanning R. limestone, Fanning R. about 2 miles upstream from Fanning R. homestead. Givetian. Transverse section, young stage.

Fig. 8. F 4924. Burdekin Downs, fence running North from East end of night paddock. Givetian. *a*, transverse and *b*, vertical section.

Fig. 9. F. 4471 Limestone on road on left bank of Fanning R. about 1½ miles above Fanning R. homestead. Givetian. Transverse section.

Fig. 10. F 5166. Burdekin Downs, limestone dam. Givetian. Vertical section.

Fig. 11. F 5315. Reid Gap, portion 81v, parish of Wyoming, lower part of limestone. Givetian. Transverse section, young stage.

Lyrielasma curvatum sp. nov.

Fig. 12. F 4423. Holotype. Base of Fanning R. limestone, Fanning R. about 2 miles upstream from Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 13. F 4502. Base of Fanning R. limestone, Fanning R. about 2 miles upstream from Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 14. F 4453. Base of Fanning R. limestone, Fanning R. about 2 miles upstream from Fanning R. homestead. Givetian. Transverse section.

PLATE VI.

Except where otherwise stated, the specimens are all in the University of Queensland Collection.

Figs. 1-4 and 10-13 × 1.8 diameters.

Figs. 5-9 natural size.

Lyrielasma? lophophylloides sp. nov.

Fig. 1. F 5129. Holotype. Burdekin Downs, limestone dam. Givetian. Transverse section.

Fig. 2. F 5127. Burdekin Downs, limestone dam. Givetian. *a*, transverse and *b*, vertical section.

Yabeia salmoni sp. nov.

Fig. 3. F 5025. Holotype. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. Transverse section. A section of *Disphyllum gregorii* is also seen.

Fig. 4. F 5022. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. Vertical section.

Calceola sandalina sandalina (*Linnaeus*).

Fig. 5. F 5174. Burdekin Downs, limestone dam. Givetian. Weathered surfaces.

Fig. 6. F 5175. Burdekin Downs, limestone dam. Givetian. Polished vertical section, showing operculum at top. The apical part is damaged by weathering.

Calceola sandalina alta Richter.

Fig. 7. F 5173. Burdekin Downs, limestone dam. Givetian. Flat side, slightly weathered.

Fig. 8. F 4465. Fanning R. station, limestone on road on left bank of Fanning R., about 1½ miles upstream from homestead. Flat side, weathered.

Fig. 9. F 4466. Fanning R. station, limestone on road on left bank of Fanning R., about 1½ miles upstream from homestead. Polished vertical section.

''Cystiphyllum'' australe Etheridge.

Fig. 10. F 1652. Geological Survey of Queensland Collection. Lectotype. Regan's, Reid Gap. Givetian. *a*, transverse and *b*, vertical section.

Fig. 11. F 4900. Burdekin Downs, fence running North from East end of night paddock. Givetian. Transverse section.

Fig. 12. F 4901. Burdekin Downs, fence running North from East end of night paddock. Givetian. Transverse section.

Fig. 13. F 5088. Burdekin Downs, limestone dam. Givetian. *a*, transverse and *b*, vertical section.

PLATE VII.

Except where otherwise stated, the specimens are all in the University of Queensland Collection.

All figures × 1.8 diameters.

''Cystiphyllum'' cf. *pseudoseptatum* Schulz.

Fig. 1. F 4537. Fanning R., dome in Fanning R. by cow paddock tank. Givetian. *a*, transverse and *b*, vertical section.

Mesophyllum collare sp. nov.

Fig. 2. F 4392. Bed c, Fanning R, limestone, Fanning R. about 1½ miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section, the latter placed sideways owing to exigencies of space.

Mesophyllum (*Dialithophyllum*) *fultum* sp. nov.

Fig. 3. F 4535. Holotype. Dome in Fanning R. by cow paddock tank, Fanning R. station. Givetian. *a*, transverse and *b*, vertical section.

Fig. 4. F 4536. Dome in Fanning R. by cow paddock tank, Fanning R. station. Givetian. Transverse section.

PLATE VIII.

Except where otherwise stated, the specimens are all in the University of Queensland Collection.

All figures × 1.8 diameters.

Disphyllum gregorii (Etheridge).

Fig. 1. F D34, Geological Survey of Queensland Collection. Paratype. Regan's, Reid Gap. Givetian. Transverse section.

Fig. 2. F 4437. Base of Fanning R. limestone, Fanning R. about 2 miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 3. F 4448. Base of Fanning R. limestone, Fanning R. about 2 miles above Fanning R. homestead. Givetian. Vertical section.

Fig. 4. F 5021. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Disphyllum (or *Macgeea*) *trochoides* sp. nov.

Fig. 5. F 4557. Holotype. Fanning R. station, windmill 3 miles ESE of homestead. Givetian. Transverse section.

Fig. 6. F 4560. Fanning R. station, windmill 3 miles ESE of homestead. Givetian. *a*, vertical section; *b*, transverse section of young stage.

Fig. 7. F 5246. Reid Gap, portion 370 parish of Magenta, lower bed. Givetian. *a*, transverse and *b*, vertical section.

Fig. 8. F 5248. Reid Gap, portion 370 parish of Magenta, lower bed. Givetian. Transverse section.

Fig. 9. F 4911. Burdekin Downs, fence running North from East end of night paddock. Givetian. *a*, transverse and *b*, vertical section.

Fig. 10. F 4970. Burdekin Downs, hill behind fowlyard. Givetian. *a*, transverse and *b*, vertical section.

Disphyllum (or *Macgeea*) *excavatum* sp. nov.

Fig. 11. F D42, Geological Survey of Queensland Collection. Holotype. Burdekin Downs. Givetian. *a*, transverse and *b*, vertical section; *c*, transverse section of young stage. *a* shows the effect of crushing.

Fig. 12. F 13 (in red), Geological Survey of Queensland Collection. Burdekin Downs. Givetian. *a*, transverse and *b*, vertical section.

Fig. 13. F 5322. Reid Gap, portion 370 parish of Magenta, 30 ft. above lower bed. Givetian. Transverse section.

Endophyllum abditum var. *columna* var. nov.

Fig. 14. F 4274. Top of Fanning R. limestone, road on left bank of Fanning R., 1½ miles above Fanning R. homestead. Givetian. Transverse section.

PLATE IX.

Except where otherwise noted, the specimens are all in the University of Queensland Collection.
All figures × 1.8 diameters.

Endophyllum abditum var. *columna* var. nov.

Fig. 1. F 4275. Holotype. Top of Fanning R. limestone, road on left bank of Fanning R. 1½ miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Favistella rhenana (Frech).

Fig. 2. F 4409. Fanning R. limestone, on Fanning R. 1½-2 miles above homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 3. F BD. Geological Survey of Queensland Collection. Burdekin Downs. Givetian. *a*, transverse and *b*, vertical section.

Fasciphyllum ryani sp. nov.

Fig. 4. F 5018. Holotype. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian.

Fig. 5. F 5364. Calcium (probably Ryans Quarry). Givetian. *a*, transverse and *b*, vertical section.

Spongophyllum immersum sp. nov.

Fig. 6. F Z82. Geological Survey of Queensland Collection. Holotype. Burdekin Downs, Arthur's Ck. Givetian. *a*, transverse and *b*, vertical section.

Grypophyllum sp.

Fig. 7. F 4501. Base of Fanning R. limestone, Fanning R. 2 miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

PLATE X.

Except where otherwise noted, the specimens are all in the University of Queensland Collection.
All figures × 1.8 diameters.

Grypophyllum compactum sp. nov.

Fig. 1. F 5317. Holotype. Reid Gap, portion 81v parish of Wyoming, lower part of limestone. Givetian. *a*, *b*, transverse sections, *b*, shows method of increase.

Fig. 2. F 5314. Reid Gap, portion 81v parish of Wyoming, lower part of limestone. Givetian. Vertical section.

Fig. 3. F 5316. Reid Gap, portion 81v parish of Wyoming, lower part of limestone. Givetian. Transverse section.

Fig. 4. F 5307. Reid Gap, portion 81v parish of Wyoming, lower part of limestone. Givetian. Transverse section.

Stringophyllum quasinormale sp. nov.

Fig. 5. F 4528. Holotype. Base of Fanning R. limestone. Fanning R. about 2 miles above Fanning R. Homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 6. F 5139. Burdekin Downs, limestone dam. Givetian. Transverse section.

Fig. 7. F 5247. Reid Gap, portion 370 parish of Magenta, lower bed. Givetian. *a*, transverse and *b*, vertical section.

Fig. 8. F 5081. Burdekin Downs, limestone dam. Givetian. Transverse section.

Fig. 9. F 5083. Burdekin Downs, limestone dam. Givetian. Vertical section.

Stringophyllum quasinormale, var ?.

Fig. 10. F 5087. Burdekin Downs, limestone dam. Givetian. *a*, transverse and *b*, vertical section.

Stringophyllum quasinormale var. *ana* var. nov.

Fig. 11. F 5011. Holotype. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Fig. 12. F 5027. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Fig. 13. F 5007. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

Fig. 14. F 5006. Burdekin Downs, anabranch of Burdekin R. near Big Rocks. Givetian. *a*, transverse and *b*, vertical section.

PLATE XI.

Except where otherwise noted, all specimens are in the University of Queensland Collection.

All figures × 1.8 diameters.

Stringophyllum bipartitum sp. nov.

Fig. 1. F 4398. Holotype. Bed c, Fanning R. limestone, Fanning R. about 1½ miles above Fanning R. homestead. Givetian. Transverse section.

Fig. 2. F 4396. Bed c, Fanning R. limestone, Fanning R. about 1½ miles above Fanning R. homestead. Givetian. *a*, transverse section, *b*, vertical section along fossula and *c*, vertical section across fossula.

Fig. 3. F 5366. Ryan's Qy., Calcium, Reid Gap. Givetian. Transverse section.

Stringophyllum irregulare sp. nov.

Fig. 4. F 4904. Holotype. Burdekin Downs, fence running North from East end of night paddock. Givetian. Transverse section.

Fig. 5. F 4895. Burdekin Downs, fence running N from E end of night paddock. Givetian. *a*, transverse and *b*, vertical section.

Fig. 6. F 4893. Burdekin Downs, fence running N from E end of night paddock. Givetian. Vertical section.

Fig. 7. F 4897. Burdekin Downs, fence running N from E end of night paddock. Givetian. Transverse section.

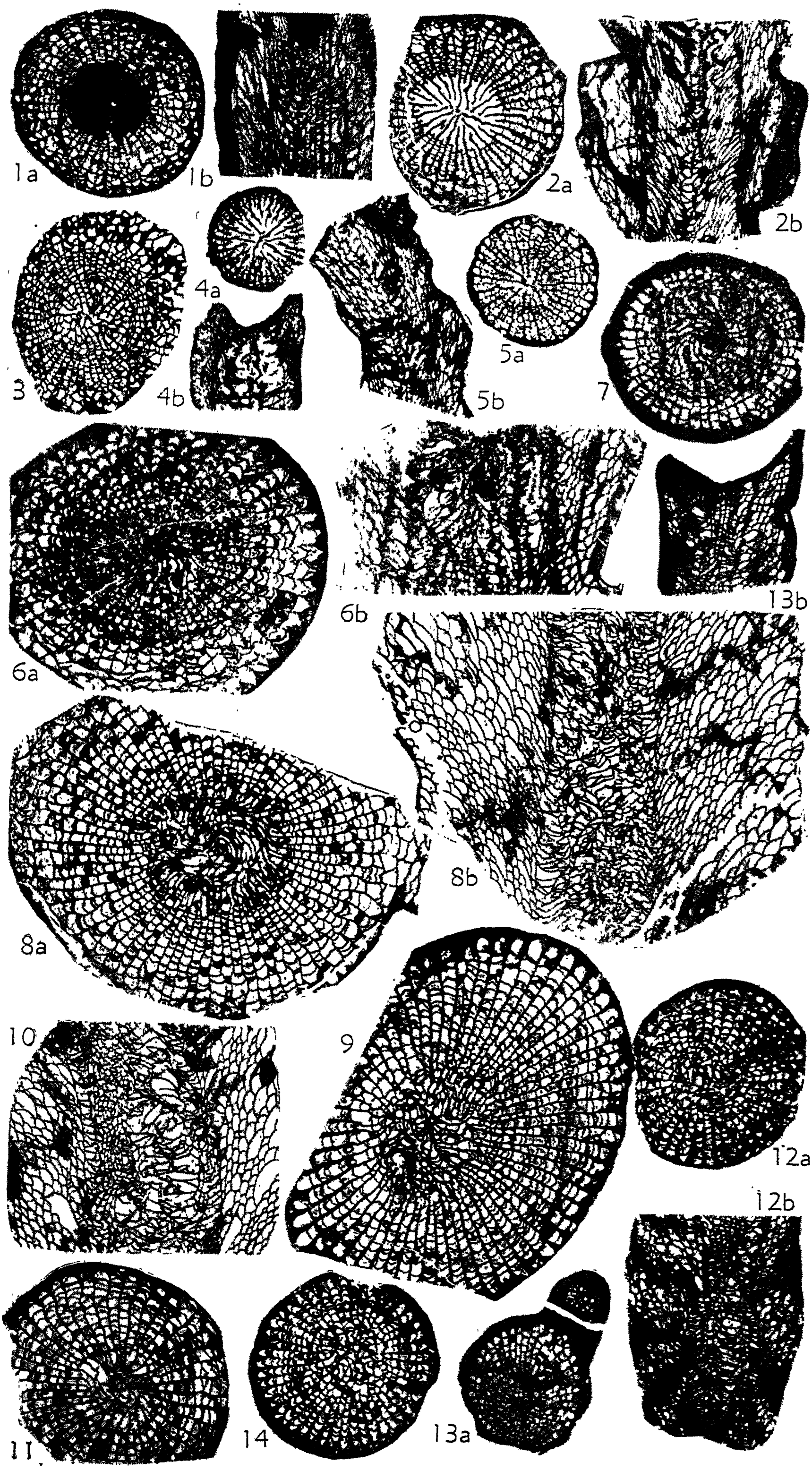
Fig. 8. F 4906. Burdekin Downs, fence running N from E end of night paddock. Givetian. Transverse section.

Stringophyllum isactis (Frech).

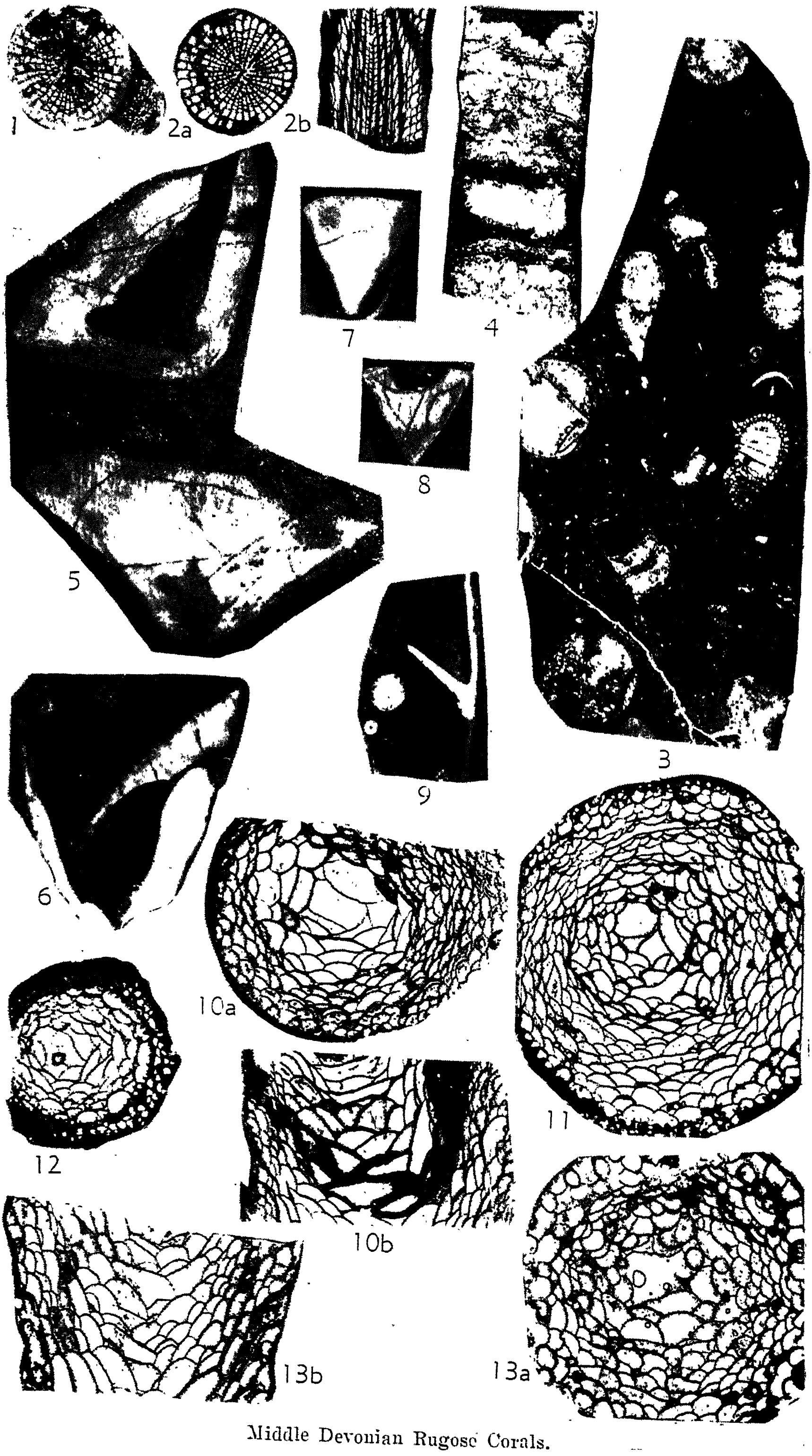
Fig. 9. F 4365. Top of Fanning R. limestone, road on left bank of Fanning R., about 1½ miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical section.

Fig. 10. F 4366. Top of Fanning R. limestone, road on left bank of Fanning R., about 1½ miles above Fanning R. homestead. Givetian. *a*, transverse and *b*, vertical seition.

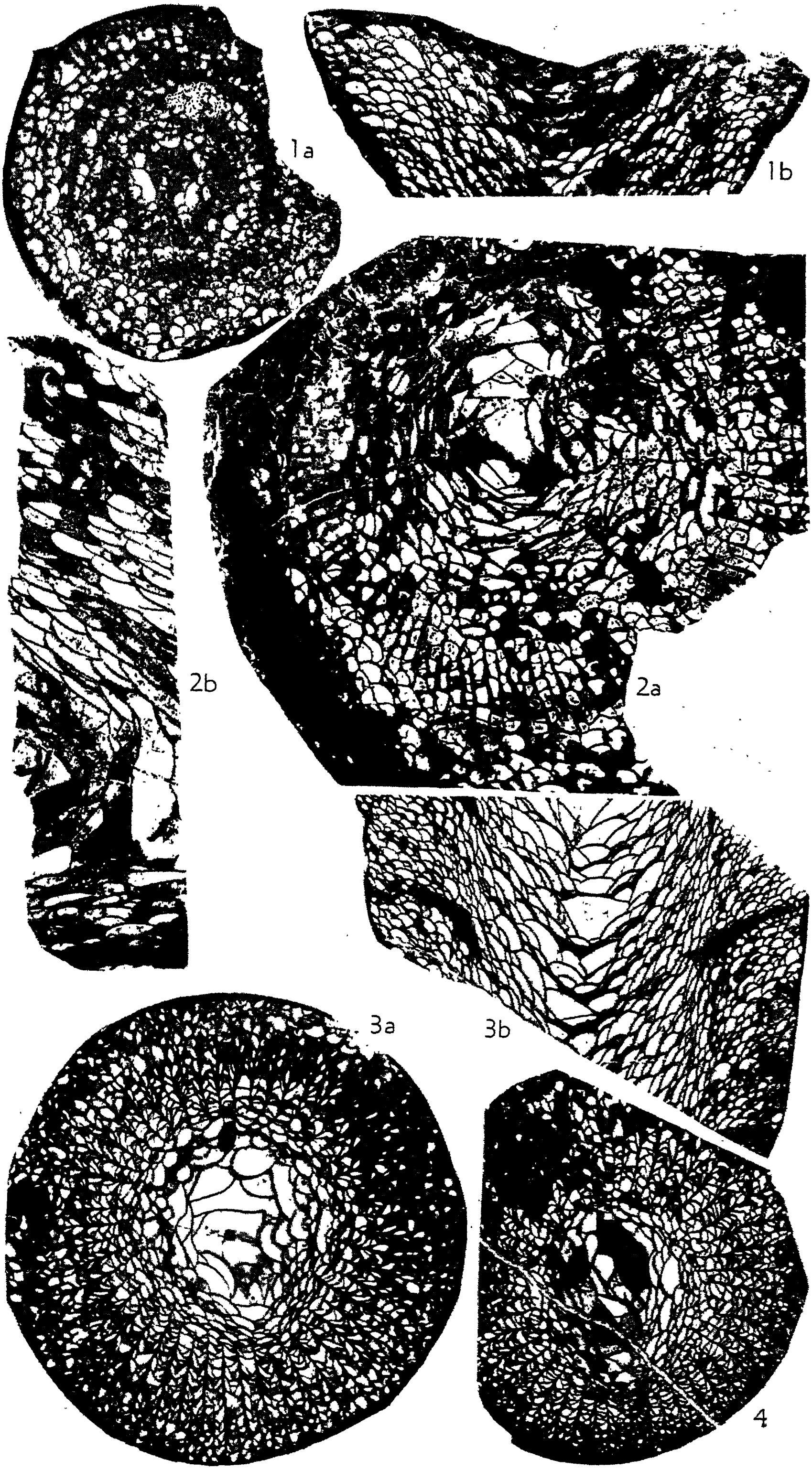
Fig. 11. F 4367. Top of Fanning R. limestone, road on left bank of Fanning R., about 1½ miles above Fanning R. homestead. Givetian. Transverse section.



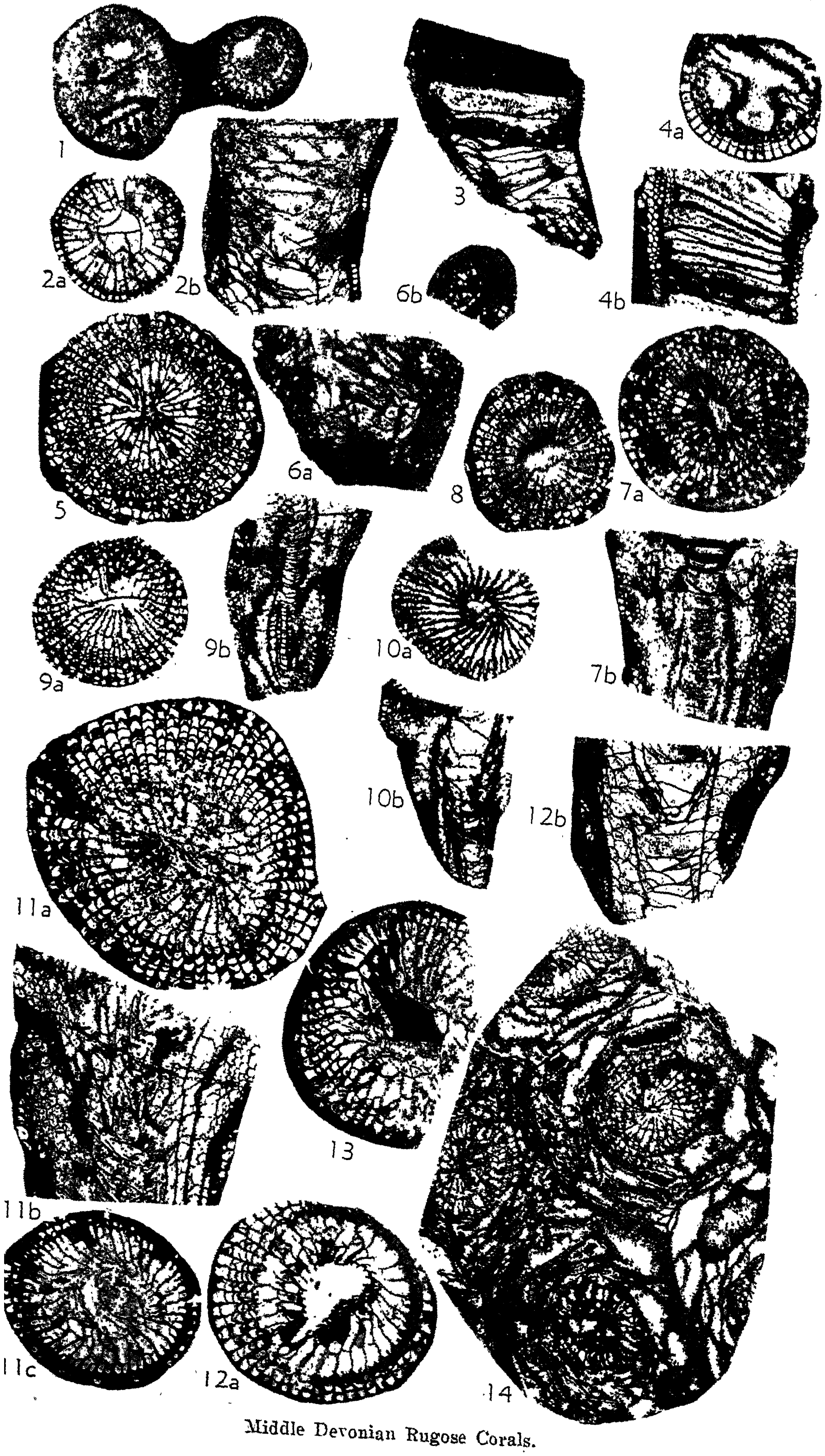
Middle Devonian Rugose Corals.



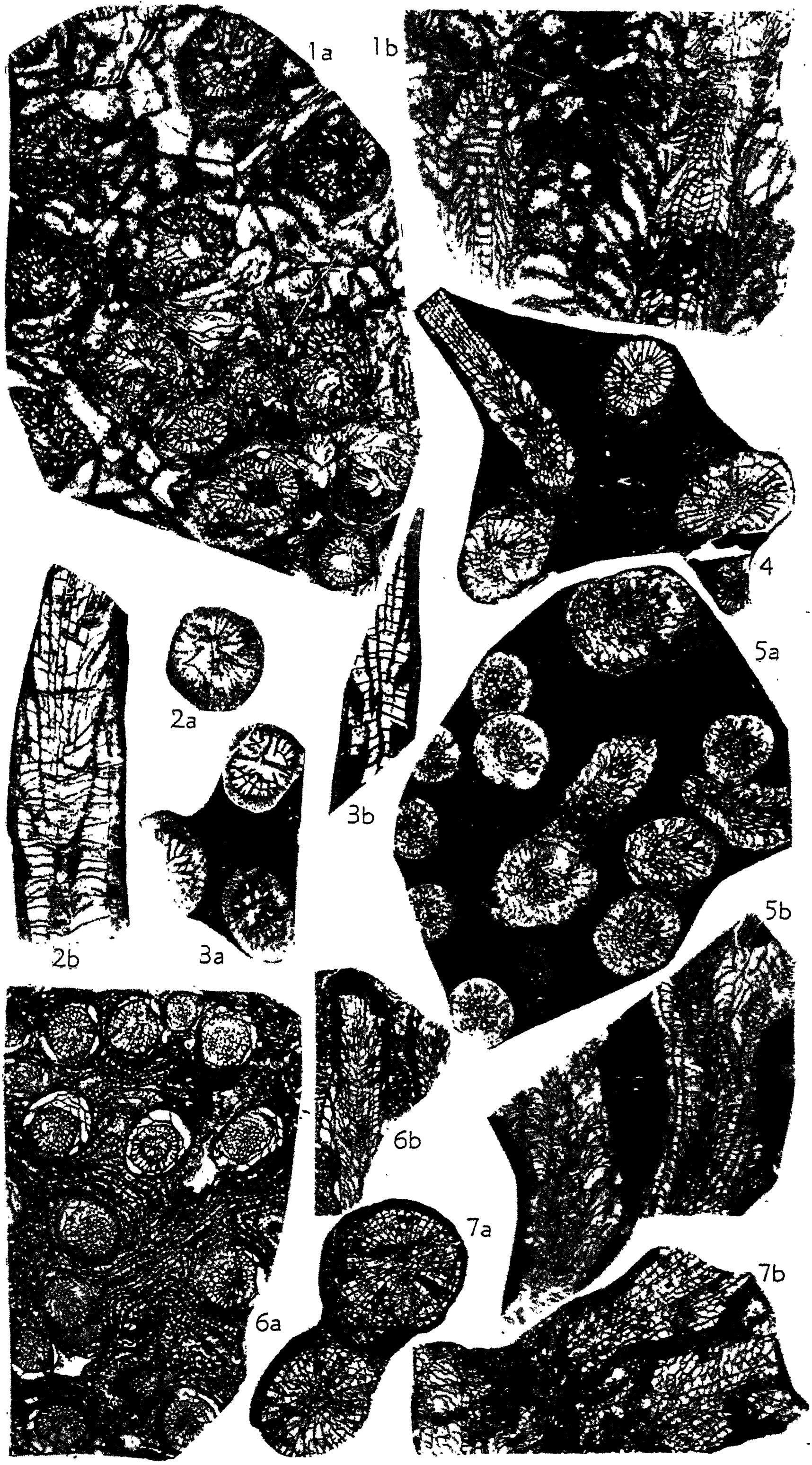
Middle Devonian Rugose Corals.



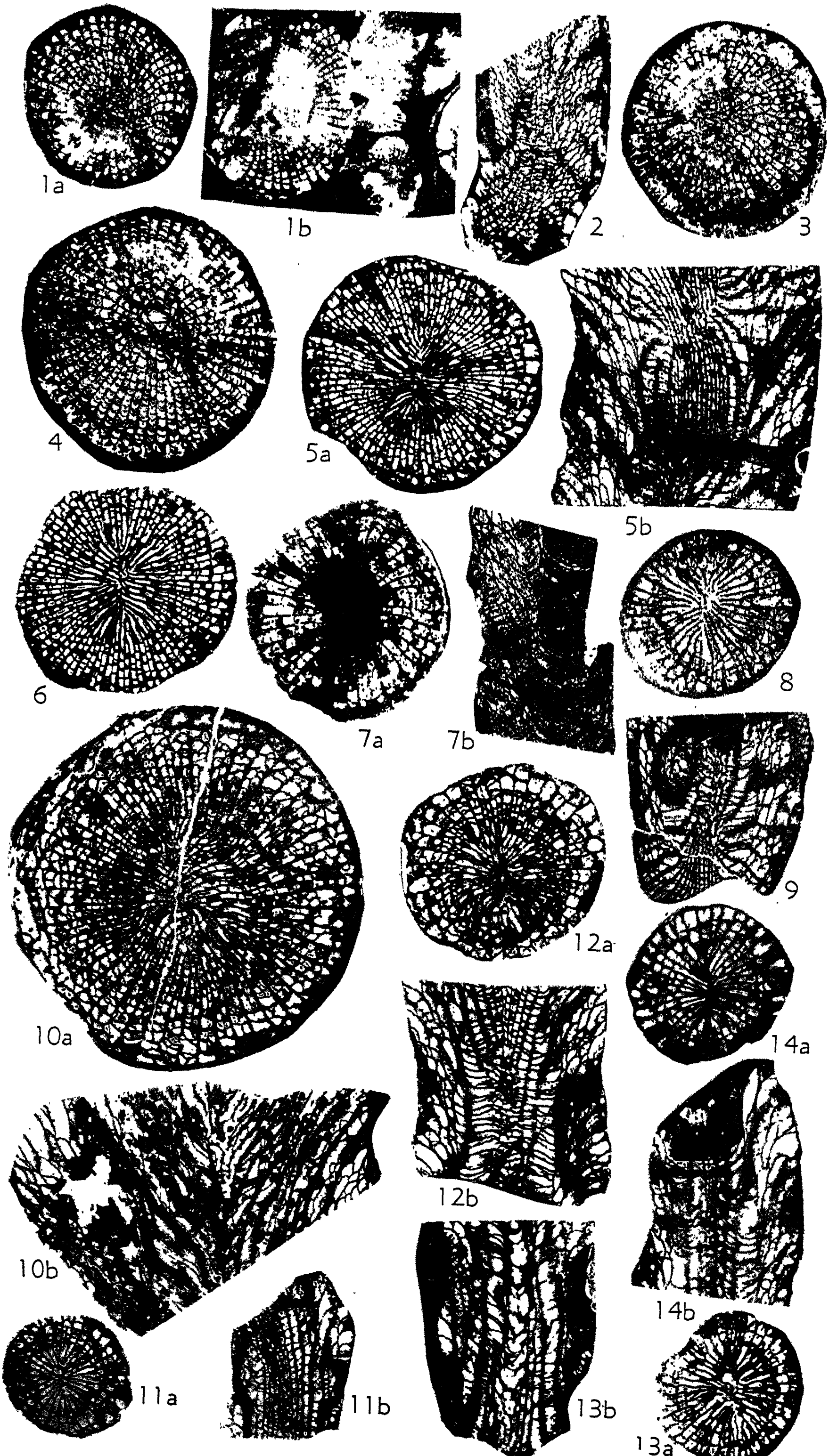
Middle Devonian Rugose Corals.



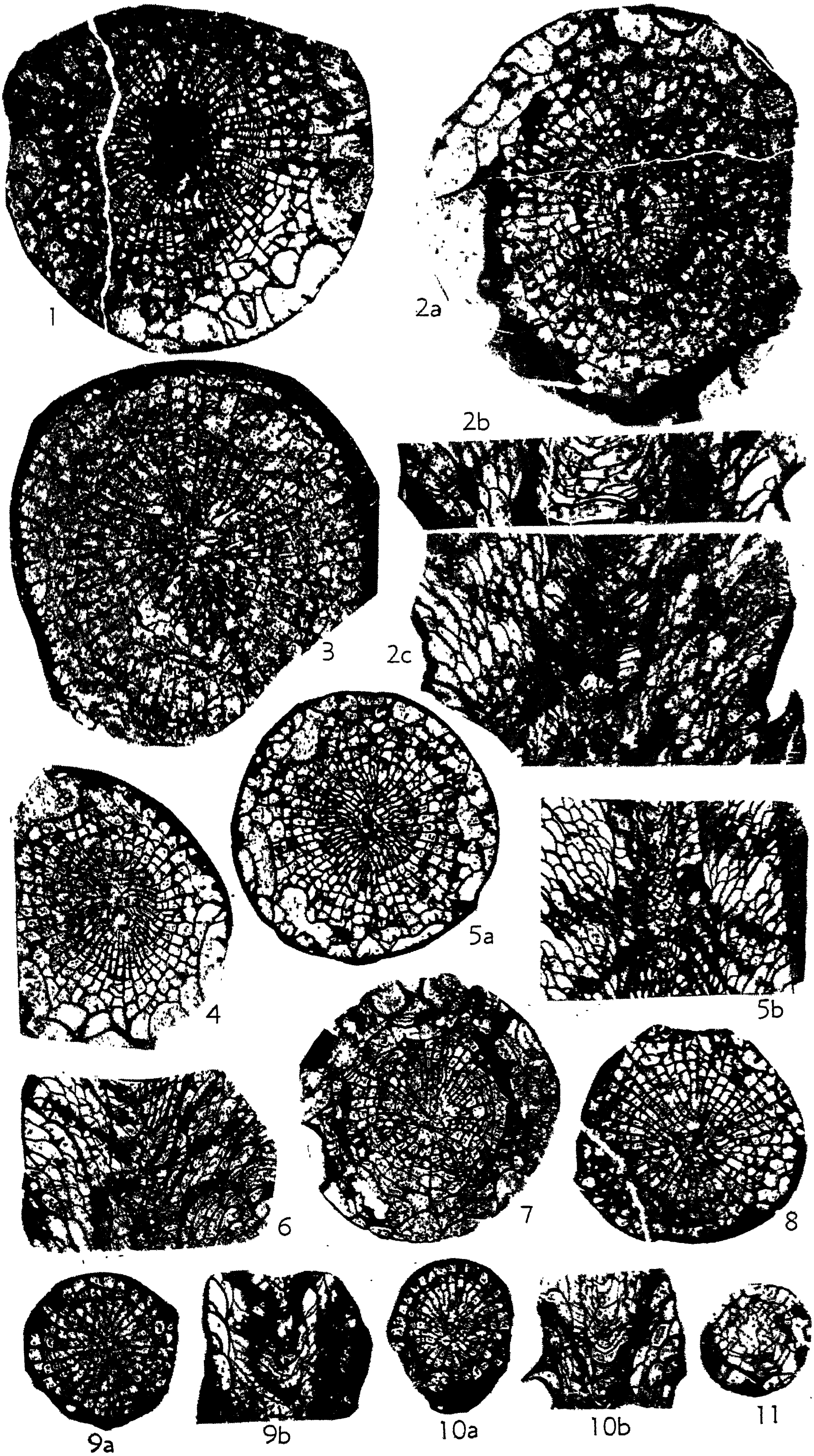
Middle Devonian Rugose Corals.



Middle Devonian Rugose Corals.



Middle Devonian Rugose Corals.



Middle Devonian Rugose Corals.

The Royal Society of Queensland.

Report of Council for 1940.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting the report for the year 1940.

Eleven original papers were read or tabled at Ordinary Meetings, and accepted for publication in the Proceedings; three symposia were held, and one meeting was devoted to exhibits. The average attendance was thirty-four.

In terms of the Government decision that the Chief Secretary's Department would pay a subsidy for printing on the basis of £1 for £1 up to a maximum of £150 per annum on papers of value from a Government point of view, the Society has this year received a subsidy of £66 on the volume for 1939. Also, the University made available £15 from the C.S.I.R. Publication Fund towards the cost of certain papers. These subsidies the Council acknowledges with gratitude.

There are at present 5 honorary life members, 4 life members, 4 corresponding members, 198 ordinary members, and 3 associate members. This year we have lost 5 members by resignation; 11 new members and 2 new associate members were elected. Several members are on active service abroad, and others are engaged in special scientific work for the war effort.

The rearrangement of the periodicals in the library has been completed, and the librarian has finished a catalogue of the American section. Two hundred and thirty periodicals are on our exchange lists, but many have not yet been received owing to war conditions.

Attendance at Council meetings was as follows:—E. W. Bick, 9; D. A. Herbert, 7; D. Hill, 8; D. H. K. Lee, 6; H. A. Longman, 6; F. A. Perkins, 8; H. C. Richards, 7; F. H. S. Roberts, 7; H. R. Seddon, 7; J. H. Smith, 6; K. Watson, 9; M. White, 5; F. W. Whitehouse, 6.

F. W. WHITEHOUSE, President.

D. HILL, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31st DECEMBER, 1940.

Cr. | Dr.

RECEIPTS.	£ s. d.
Balance in Commonwealth Bank, 31st December, 1939	172 17 6
Cash in hand	0 7 6
Subscriptions	172 4 0
Sales of Reprints	1 7 4
Subsidy from University	15 0 0
Interest on Commonwealth Loan	4 11 3
Savings Bank Interest	3 16 8
Refreshments Account, Collections	3 10 9
Exchanges	0 2 6
	£373 17 6

EXPENDITURE.		£ s. d.
Government Printer, Abstracts and Report		16 13 8
Government Printer, Volume of Proceedings	£268 7 10	
Less Government Subsidy	66 0 0	
	£202 7 10	202 7 10
State Government Insurance (Library)		0 19 2
Hon. Secretary, Postages		14 8 0
Hon. Librarian, Postages		3 15 7
Hon. Treasurer, Postages and Duty		2 0 0
Refreshments		4 12 0
Furniture		2 14 8
Balance in Commonwealth Bank		126 6 7
		£373 17 6

Audited and found correct.

A. J. M. STONEY, B.E.E., Honorary Auditor.

18th March, 1941.

E. W. BICK, Honorary Treasurer.

Abstract of Proceedings, 25th November, 1940.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University on Monday, 25th November, at 8 p.m., with Professor H. R. Seddon in the chair. Apologies for absence were received from Drs. F. W. Whitehouse, D. Hill, and A. J. Turner.

Mr. R. F. Langdon, B.Agr.Sc., exhibited specimens and photomicrographs of *Claviceps pusilla,* the fungus responsible for ergot of Queensland Blue Grass (*Dicanthium sericeum*). This fungus has not previously been recorded from Australia.

Dr. D. A. Herbert exhibited specimens of dahlia affected by the yellow ringspot virus at present classified as Dahlia Virus 2A. This disease appeared on seedling dahlias in 1939.

The following papers were read:—

(1) "Notes on Australian Cyperaceae V.," by S. T. Blake, M.Sc.

(2) "The Vegetation of the Lower Stanley River Basin," by S. T. Blake, M.Sc.

(3) "Spherulitic Crystallization as a Mechanism of Skeletal Growth in the Hexacorals," by W. H. Bryan, M.C., D.Sc., and Dorothy Hill, M.Sc., Ph.D.

(4) "Latent Infection in Tropical Fruits and the Part Played by the Genus Gloeosporium," by J. H. Simmonds, M.Sc.

(5) "Preliminary Note on Photosensitization of Sheep Grazed on *Brachiaria brizantha,*" by N. W. Briton, B.V.Sc., and T. B. Paltridge, B.Sc.

A paper by A. J. Turner, M.D., F.R.E.S., entitled "Fragmenta Lepidopterologica," was laid on the table.

Abstract of Proceedings, 31st March, 1941.

The Annual General Meeting of the Society was held in the Department of Geology of the University on Monday, 31st March, 1940. An apology was received from the Patron, His Excellency the Governor. Fifty-three members and friends were present. The minutes of the previous annual meeting were read and confirmed. The Annual Report and Balance-sheet were adopted. Mr. R. Pennington, M.A., and Mr. N. W. Briton, B.V.Sc., were nominated for Ordinary Membership.

The following officers and Council were elected for 1941:—President, Prof. H. R. Seddon; Vice-Presidents, Dr. F. W. Whitehouse and Prof. D. H. K. Lee; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Dr. D. Hill; Hon. Librarian, Miss K. Watson; Hon. Editors, Dr. W. H. Bryan and Dr. F. H. S. Roberts; Members of the Council, Prof. J. Bostock, Prof. R. W. H. Hawken, Dr. D. A. Herbert, Mr. J. H. Smith, and Dr. M. White; Hon. Auditor, Mr. L. P. Herdsman.

The retiring President, Dr. F. W. Whitehouse, inducted to the Chair the President-Elect, Prof. H. R. Seddon. The new President then called on the retiring President to deliver the address "The Surface of Western Queensland." Mr. H. A. Longman and Dr. A. Wade expressed to Dr. Whitehouse the thanks and appreciation of the meeting for the address.

Abstract of Proceedings, 28th April, 1941.

The Ordinary Monthly Meeting of the Society was held on Monday, 28th April, in the Department of Geology of the University, with the President (Prof. H. R. Seddon) in the chair. Twenty-three members were present. The minutes of the previous meeting were read and confirmed. Messrs. R. Pennington, B.A., F.L.A., and N. W. Briton, B.Vet.Sc., were unanimously elected Ordinary Members and Miss. M. Hardy, B.Sc., and Messrs. A. W. Beasley, R. H. Hyland, and V. N. Love were proposed for Associate Membership.

Dr. W. H. Bryan exhibited a specimen of rhyolite collected by Mr. Arthur Groom from Binna Burra. The specimen is in the shape of an elongate fluted ribbon and was found inside a large cavernous spheruloid. Dr. Bryan demonstrated that the rhyolite was squeezed into the spheruloid through an irregular crack which acted as a die and imposed the uniform pattern on the viscous rhyolite in much the same way as "ribbon" type biscuits are produced in a biscuit factory.

Dr. M. White exhibited a sample of cumic acid derived from *p*-cymene. This was obtained by feeding sheep the *p*-cymene and recovering the excreted cumic acid conjugated with glycene in the urine. Hydrolysis of the conjugated product with dilute mineral acid readily yielded cumic acid. It is important to note that the oxidation in the animal takes place at the methyl grouping and not in the iso-propyl as occurs under laboratory conditions.

Dr. F. W. Whitehouse exhibited two new, unattached echinoderms from early Middle Cambrian deposits of north-western Queensland that are similar, generally, to larval stages (the dipleurula and free pentacula stages) of living echinoderms.

The following papers were read:—

1. "Additions to the Mosses of North Queensland," by H. N. Dixon. M.A., F.L.S., communicated by C. T. White, F.L.S.

   New species are described and new records given.

2. "The Devonian Tabulata of Douglas and Drummond Creeks, Clermont, Queensland," by O. A. Jones, M.Sc., communicated by Dr. D. Hill.

   Nine species and one variety, belonging to seven genera are described, and their fine structure noted; four of the species and the variety are new. The genotypes of *Striatopora* and *Gephuropora* are discussed. The age indicated is Lower Middle Devonian.

Abstract of Proceedings, 26th May, 1941.

The Ordinary Monthly Meeting of the Society was held on Monday, 26th May, in the Department of Geology of the University, with the President (Prof. H. R. Seddon) in the chair. Twenty members were present. The minutes of the previous meeting were read and confirmed. Miss M. Hardy, B.Sc., and Messrs. A. W. Beasley, R. H. Hyland, and V. N. Love were elected Associate Members, and Miss K. W. Robinson, M.Sc., Miss B. J. Money, B.Sc., Mr. N. T. M. Yeates, B.Agr.Sc., and Mr. J. G. H. Hoeben, B.V.Sc., were nominated for Ordinary Membership. It was announced that the librarian would follow the literature in special subjects for members if desired.

The President communicated the paper "Variations in the vulval linguiform Process of *Hæmonchus contortus*," by F. H. S. Roberts, D.Sc.

Dr. Wade exhibited specimens of "zebra" rock from Argyll Station, in the Kimberleys, probably from the Cambrian. The zebra-like markings are possibly due to leaching. He also showed salt crystals with stepped faces from a lake on Keratta Station.

Normally, tyrosine is excreted in a completely oxidised state as a phenol, but this process is interrupted in persons suffering from alkaptonuria, and homogentisic acid or p-hydroxyphenylpyruvic acid is excreted. A number of the reactions of the former substance obtained from the urine of a person with this rare error of metabolism were shown by Mr. J. P. Callaghan.

Miss Watson exhibited a very large *Chama* sp. from 17 fathoms in Boucaut Bay, near Darwin; and also a number of aboriginal stone implements collected by Mr. H. V. V. Noone, mainly from E. Sibley's sand pit at Lindum. These included a number of types already known from south-east Queensland, and some, mainly the arapia, a semi-discoidal piece, and a few microlithic pieces new to the locality. A few elouera from Bundaberg were included.

Mr. S. T. Blake exhibited *Halophila ovalis* and *Zostera muelleri* collected in flower and fruit in December on the sandbanks off Myora, in Moreton Bay, where they are important colonisers.

Dr. M. White exhibited (1) a peanut (*Arachis*) growing in a fungus and showing aerial fruiting. A secondary growth of fungus enveloped part of the plant; (2) portion of a stone-like impaction taken from the omasum of a cow that had died from earth eating; (3) a number of calculi composed chiefly of $CaCO_3$ taken from the urinary tract of sheep.

Prof. Seddon exhibited a marsupial bone taken from the paunch of a cow; also a maize unsheathing tool used by the Maoris and made from the rib-bone of an ox.

Dr. Hill exhibited *Protocanites planorbiformis* and ? *Pseudarietites ammonitiformis*, with associated brachiopods and gastropods, from por. 86, par. Neerkol, west of Rockhampton.

ABSTRACT OF PROCEEDING, 30TH JUNE, 1941.

The Ordinary Monthly Meeting of the Society was held on Monday, 30th June, in the Sir William Macgregor School of Physiology, with the President (Prof. H. R. Seddon) in the chair. About sixty were present. The minutes of the previous meeting were read and confirmed. Miss K. W. Robinson, M.Sc., Miss B. J. Money, B.Sc., Mr. N. T. M. Yeates, B.Agr.Sc., and Mr. J. G. H. Hoeben, B.V.Sc., were elected Ordinary Members. The following papers were read and discussed:—

1. "Note on a grooved and polished granite surface near Eulo, Western Queensland," by A. Wade. The markings were considered to be aboriginal artefacts rather than of glacial origin. A review of knowledge of Cretaceous glacial action in Australia was given.

2. "Reactions of Domestic Fowls to Hot Atmospheres." N. T. M. Yeates, D. H. K. Lee, and H. J. G. Hines. Preliminary investigations are described, and methods and results given. Effects upon heart

rate, rectal temperature, respiratory rate, and weight loss were measured. Atmospheres of dry bulb temperatures 70-110° F., and of relative humidities 25-95 per cent. were used. Modifications of reactions by varying the amount of drinking water and the protein level of the diet were also studied. Australorps were compared with White Leghorns Four hens were used in each experiment. Figures were given of individual and seasonal variations. Physiological results were given in some detail, and the following practical applications recorded:—Temperatures above 80° F. produce disturbances. Temperatures of 100° F. and above cannot be withstood for seven hours, especially if humidity is high. Humidity is of consequence only at high temperatures. Good water supply into which fowls can dip head is required. The protein level of the diet is apparently immaterial. A rectal temperature of 113° F. is the highest the fowl can reach before developing heat stroke. White Leghorns can definitely withstand heat better than Australorps.

3. "Reactions of the Rabbit to Hot Atmospheres." D. H. K. Lee, K. Robinson, and H. J. G. Hines. Effects upon respiratory volume as well as heart rate, rectal temperature, respiratory rate, and weight loss were studied. The effects of atmospheres of different composition, different amounts of drinking water, and repeated exposure were examined. (See previous paper.) One rabbit (male white angora) was used in each experiment. Physiological results were given in some detail, and the following conclusions reached:—The tolerance of the rabbit resembles that of the fowl. Half replacement of water improves the rabbit's reactions. Seasonal variations are complex and important. The respiratory rate may rise to 720, but tidal volume is little reduced. Individual variation is fairly great.

4. "Reactions of the Pig to Hot Atmospheres." K. Robinson and D. H. K. Lee. Studies were made in parallel with those upon the rabbit. The following conclusions were reached:—The tolerance of the pig for hot atmospheres resembles that of the fowl and rabbit. Humidity is important at high temperatures, but not at intermediate temperatures. The respiratory rate may rise to 280, but the tidal volume is reduced to a half or less. Unlike the fowl and the rabbit, the pig's reactions to heat include a definite rise in pulse rate. Half replacement of water is accompanied by definite improvement in the reactions. Atmospheric conditions between experiments are of importance. Variation between individuals may be large. Salivation up to 500 ccs. per hour may occur. Growth and meat quality are not affected by severe heat experiences.

Abstract of Proceedings, 28th July, 1941.

The Ordinary Monthly Meeting of the Society was held on Monday, 28th July, in the Department of Geology of the University, with the President (Prof. H. R. Seddon) in the chair. About thirty were present. The minutes of the previous meeting were read and confirmed.

Mr C. E. Ogilvie exhibited pads of grass seed (*Aristida arenaria* and *A. anthoxanthoides*) and of hardened mud from the legs and feet of sheep.

A discussion on "Scientific Societies in Post-war Organisation" was held. The President (Prof. H. R. Seddon), in introducing the

discussion, considered that post-war organisation should be planned, and that the Society should give whatever assistance it could to make such plans scientifically sound.

Prof. J. Bostock emphasised that the community needed to prepare plans to combat post-war economic difficulties, and that the scientific method should be used in the preparation and execution. As much as possible should be done to reduce the psychological conflicts in individuals due to social insecurity, for these conflicts adversely affected the health of both individual and community; they created an emotional bias which is inimical to clear reasoning; in his opinion the desired social security could not be obtained without socialisation. He urged that post-war construction be viewed from the psychological standpoint.

Prof. D. K. Lee asked that administrators, through scientists, should be acquainted with the great biological laws, for no plan could succeed which contravened these laws. In any changes made, man should be allowed freedom of expression, without which he could not exercise his power of abstract thought; he should be given security, without which creative effort is impossible; he should have optimum nutrition, particularly in the "outback"; more should be done in the prevention of ill-health; and communal effort should be fostered, but without the elimination of competition.

Mr. C. Schindler, Dr. Lockhart Gibson, Mr. F. Gipps, Prof. R. W. Hawken, Mr. H. J. G. Hines, and Mr. K. V. Kesteven joined in the discussion. Points made were that the plans should not submerge the individual; that people should be shown how best to use their leisure; that plans for peace treaties should make it impossible for aggressor nations to overrun others; that all administrators should have training in the scientific method, and all scientists be taught administration; that social security should be considered an essential for all; and that plans made should include some for the preventing of waste in the dissemination of results of scientific investigations.

Mr. H. Tryon moved that a committee be formed to consider how the Society might assist in planning, and the President, Prof. Bostock, Prof. Lee, and Mr. Hines were appointed.

Abstract of Proceedings, 25th August, 1941.

The Ordinary Monthly Meeting of the Society was held on Monday, 25th August, 1941, in the Department of Geology of the University, with the Vice-President, Prof. D. H. K. Lee in the chair. About twenty members were present. The minutes of the previous meeting were confirmed. Prof. Lee asked permission to read papers of which the following are authors' abstracts:—

"Reactions of the Cat to Hot Atmospheres."—K. Robinson and D. H. K. Lee. Investigations were made in parallel with those of the Fowl, Rabbit, and Pig. Effects upon respiratory volume as well as heart rate, rectal temperature, respiratory rate and weight loss were studied. The effects of atmospheres of different composition, different amounts of drinking water and repeated exposure were examined. Physiological results were given in some detail and the following conclusions reached:—The cat shows far less reaction to heat than the fowl, rabbit, or pig. Temperatures of 105 degrees F. cannot be tolerated if the humidity is above 65 per cent. Humidity has a definite effect. Oral replacement of water affects only tidal and respiratory volumes. The

pulse rate tends to rise with rectal temperature. Tidal volume is only slightly reduced with rise of respiratory rate. Increased respiratory evaporation comes into action before body temperature rises. At body temperatures above 104 degrees F. use is made of saliva to increase evaporation from its coat.

"*Reactions of the Dog to Hot Atmospheres.*"—K. Robinson and D. H. K. Lee. Methods of investigation were similar to those of the cat. The following conclusions were reached:—The tolerance of the dog to hot atmospheres is slightly greater than that of the cat. The The effect of humidity is marked. With rise of respiratory rate tidal volume is greatly reduced up to $\frac{1}{5}$ of the usual value. Half replacement of water is accompanied by definite improvement in the reactions. Marked acclimatisation to hot atmospheres was developed. Open-mouthed panting occurs at low body temperature. At a rectal temperature of 105 degrees F. the dog nears a crisis. At 109 degrees F. "staggers" develop.

"*Reactions of the Sheep to Hot Atmospheres.*"—D. H. K. Lee and K. Robinson. Studies were made on merino wethers in parallel with those on the cat. The following conclusions were reached:—The sheep is outstanding amongst domestic animals in tolerating hot atmospheres, withstanding for seven hours a temperature of 110 degrees F. with 65 per cent. humidity. Humidity is important, showing a close resemblance to man and the dog. Respiratory rate may rise to 240 per minute while the tidal volume is little reduced. Replacement of water is accompanied by some improvement in reaction. Panting is not a marked feature, occurring only at a rectal temperature of 106 degrees F.

Dr. F. H. S. Roberts addressed the meeting on "Methods of Control of Blowfly Strike in Sheep." He outlined the predisposing factors which render sheep attractive to the primary fly and then proceeded to show how these factors are best countered. The main lines of attack are—(*a*) Breeding of plain-bodied as opposed to "wrinkly" sheep; (*b*) culling sheep with other predisposing conformations and wool characteristics; (*c*) Mule's operation; (*d*) Carcase destruction; (*e*) Jetting and swabbing; (*f*) Crutching. The lecture was illustrated with photographs and a film taken and exhibited by Mr. K. Kesteven.

ABSTRACT OF PROCEEDINGS, 29TH SEPTEMBER, 1941.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 29th September, with the President (Prof. H. R. Seddon) in the chair. About forty members were present. A welcome was extended to Mr. R. E. Holttum, Director of the Botanic Gardens, Singapore. The minutes of the previous meeting were read and confirmed.

Mr. C. T. White read a paper " Contributions to the Queensland Flora, No. 7," of which the following is the author's abstract:—

The paper contains additions to the flora of Queensland made since the publication of the previous contribution (these Proceedings, Vol. 50, pp. 66-87). A number of new species are described, and several plants recorded for the State for the first time. One family (Dichapetalaceæ or Chailletiaceæ) and a genus (*Gærtnera*-Loganiaceæ) are added to the Australian flora.

During the discussion on the paper it was resolved, on the motion of Mr. H. Tryon and Mr. White, that a committee, consisting of Mr. White, Dr. Herbert, Mr. Francis, and Mr. Blake, investigate, in association with workers in other States, the possibilty of the publication of an eighth volume of Bentham's "Flora australiensis."

Mr. J. Hanson-Lowe gave an address on "The Climate of the South Chinese-Tibetan Borderland." He said that two-seasonal (wet and dry) South-eastern Tibet lies on the marginal fringe of "Monsoon Asia," and is a transitional area in which the dry, highly continental climate of West Tibet contends with the farthest outpost of the sub-tropical monsoon climate, the peculiar relief (undulating plateau incised by tremendous gorges) permitting penetration of sub-tropical conditions far inland, *via* the river trenches. To explain the summer thunderstorms of the rainy season, it is suggested that the general circulation of the main air-mass, even in summer, is from a westerly quarter; the monsoon air, largely dried after its passage over the lofty Ta Hsüeh Shan, and warmed by compression on its descent to the plateau, is undercut by the cool main air-flow, with precipitation following adiabatic cooling, and causing storms to come from a westerly or north-westerly quarter. Mr. Hanson-Lowe was accorded a vote of thanks for the address.

Mr. H. Tryon exhibited two rare botanical books.

Abstract of Proceedings, 27th October, 1941.

The Ordinary Monthly Meeting of the Society was held in the Department of Geology of the University on Monday, 27th October, with the President (Prof. H. R. Seddon) in the chair. Twenty-two members were present. The minutes of the previous meeting were confirmed.

Dr. D. Hill read a paper "The Middle Devonian Rugose Corals of Queensland, III. Burdekin Downs, Fanning R., and Reid Gap, North Queensland." *Abstract*—Twenty-three species of Rugosa, fifteen of them new, are described from the limestones of the Charters Towers and Townsville districts, with some discussions on the genera and families to which they are assigned. The fauna is very closely comparable to those of the upper Honsel (*quadrigeminus*) and Buchel (Massenkalk or *Amphipora* Banke) beds of the Paffrath Basin, near Cologne, Germany, so that its age is Givetian—and more narrowly, that middle section of the Givetian covered by the *quadrigeminus* and Buchel beds.

Mr. C. T. White exhibited specimens of *Duboisia myoporoides* R.Br., *D. Leichhardtii* F. Muell., and *D. Hopwoodii* F. Muell. (the Pituri). The first is found in Eastern Australia and New Caledonia. Queensland specimens contain the alkaloid hyoscine, and there is a steady demand for the dried leaf. *D. Leichhardtii* is confined to Queensland. *D. Hopwoodii* has been recorded for Queensland, but the exhibitor stated he knew of no authentic records; it is fairly common along the Adelaide-Perth railway.

Mr. E. F. Riek exhibited two fresh-water siliceous sponges. One was the living *Ephydatia fluviatilis* auctt. from a branch of Oxley Creek, showing gemmules; the other consisted of fossil gemmules from the Tertiary shale at Cooper's Plains, which had been provisionally regarded as ostracods.

Dr. Roberts demonstrated the stick fast flea, *Echidnophaga gallinacea*, recently found near Boonah. This is the first authentic record of the species in Eastern Australia. The flea attaches itself to the head of its host; poultry is the chief domestic animal affected, but it occurs also on native hosts. Control measures were suggested.

Dr. White exhibited specimens from the Stassfurt salt deposits, a beautifully-finished old blow-pipe, a new type Squibb funnel, and a large magnesium oxalate calculus from a horse.

Mr. Tryon exhibited a jasper artefact from Russell Island, obsidian from New Zealand, a Maori tiki, and a necklace of beads from Zimbaye, S. Rhodesia, believed to be of Persian workmanship.

Mr. R. F. Langdon exhibited a specimen of the ascigerous stage of the ergot of *Ischæmum australe*. This is one of four new species of *Claviceps* recently discovered in Queensland. Along with *C. Pusilla,* they are indigenous to Australia, and we now know that the ergot fungus occurs naturally in all continents.

ABSTRACT OF PROCEEDINGS, 24TH NOVEMBER, 1941.

A special meeting was held in the Geology Department of the University on Monday, 24th November, at 7.45 p.m., with the President (Prof. H. R. Seddon) in the chair, to consider a proposed amendment to Rule 19. It was resolved to amend Rule 19 by replacing the amendment made in July, 1933, by the following, on the motion of Dr. W. H. Bryan and Prof. H. C. Richards. "The senior non-official member of Council shall retire anually, and be not eligible for re-election as a non-official member for one year." Mr. Henry Tryon, C. T. White, and F. A. Perkins spoke against the amendment which was carried. Mr. Henry Tryon then announced his retirement from the Society, as a protest against the passing of the amendment.

The Ordinary Monthly Meeting was held in the Department of Geology of the University on Monday, 24th November, 1941, at 8 p.m. with the President (Prof. H. R. Seddon) in the chair. About thirty members were present. The minutes of the previous meeting were read and confirmed. Mr. J. Leeming Scofield, B.Sc., was unanimously elected an Ordinary Member. The report of the special committee to consider "The Royal Society and Post-War Reconstruction" was read, and it was resolved on the motion of Mr. Perkins that it be duplicated and circulated for the consideration of members, and again discussed at an early meeting.

Mr. F. A. Perkins gave a brief account of his preliminary study of a large collection of fossil insects from Mt. Crosby. About 6,000 specimens have already been obtained. He showed drawings of some homopterous tegmina which he intends to describe in the near future. Papers on the representatives of other orders will follow. Some of his material was recently obtained by Mr. J. H. Simmonds, senr., who collected the first fossil insects from Denmark Hill, Ipswich, in 1890. Specimens of the wings of *Homoptera* were tabled.

Mr. C. T. White exhibited a fruit of *Capparis canescens* from Thursday Island. The species was originally collected by Sir J. Banks at the Bay of Inlets. The exhibitor regarded it as one of the commonest and most widely spread members of the genus in Australia.

The Chairman expressed the thanks of the meeting to the lecturer and exhibitor.

The following Institutions, Societies, etc., are on our exchange list, and publications are hereby gratefully acknowledged. Owing to war conditions, many of our exchanges have temporarily lapsed.

ARGENTINE—
Universidad Nacional de la Plata.
Universidad de Buenos Aires.

AUSTRALIA—
Commonwealth Bureau of Census and Statistics, Canberra.
Department of Agriculture, Melbourne.
Department of Mines, Melbourne.
Royal Society of Victoria.
Field Naturalists' Club, Melbourne.
Council for Scientific and Industrial Research, Melbourne.
Australian Chemical Institute, Melbourne.
Department of Mines, Adelaide.
Waite Agricultural Research Institute, Glen Osmond.
Royal Society of South Australia.
Royal Geographical Society of Australasia, Adelaide.
Public Library, Museum and Art Gallery, Adelaide.
University of Adelaide.
Standards Association of Australia, Sydney.
Naturalists' Society of New South Wales.
Department of Agriculture, Sydney.
Department of Mines, Sydney.
Royal Society of New South Wales.
Linnean Society of New South Wales.
Australian Museum, Sydney.
Public Library, Sydney.
University of Sydney.
Botanic Gardens, Sydney.
Australian Veterinary Society, Sydney.
Queensland Naturalists' Club, Brisbane.
Department of Mines, Brisbane.
Queensland Museum, Brisbane.
Department of Agriculture, Brisbane.
Royal Geographical Society of Australasia (Queensland), Brisbane.
Royal Society of Tasmania.
Mines Department, Hobart.
Mines Department, Perth
Royal Society of Western Australia.
North Queensland Naturalists' Club, Cairns.
Department of Fisheries, Sydney.
Technological Museum, Sydney.
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